OPERATIVE SURGERY

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VOLUME II

OPERATIONS ON THE VISCERA CONNECTED WITH
THE PERITONÆUM. THE SCROTUM AND PENIS, AND
MISCELLANEOUS OPERATIONS, INCLUDING THOSE
FOR SOME DEFORMITIES OF THE EXTERNAL EAR

FOURTH EDITION, PRINTED FROM NEW PLATES
ENTIRELY REVISED AND LARGELY REWRITTEN

THIS VOLUME CONTAINS
EIGHT HUNDRED AND NINETY-FIVE ILLUSTRATIONS
THIRTY-NINE OF WHICH ARE COLORED

CONTENTS.

CHAPTER XIV.

OPERATIONS ON VISCERA CONNECTED WITH PERITONÆUM.

CHAPTER XV.

OPERATIONS ON ANUS AND RECTUM.

CHAPTER XVI.

OPERATIONS ON THORAX AND NECK.

CHAPTER XVIII.

OPERATIONS ON THE SCROTUM AND PENIS, AND MISCELLANEOUS OPERATIONS.

LIST OF ILLUSTRATIONS.

OPERATIVE SURGERY.

CHAPTER XIV.

OPERATIONS ON VISCERA CONNECTED WITH PERITONÆUM.

It is eminently wise before considering the surgical treatment of wounds and diseases of the abdominal viscera, that a brief statement be made of the proper method of approach to the abdominal cavity itself.

Abdominal Section, or Cœliotomy.—Abdominal section is the opening of the abdominal cavity for the purpose of considering any of the various structures or pathological changes that may be present within. *The situation* of the incision will depend on the object in view and the importance of the tissues involved, *the length* will depend on the thickness of the wall, the desired freedom of manipulation, the character of the tissues, and the seat of the division. *The direction* of the incision will depend on the part of the belly to be invaded, the subsequent strength and perhaps the disfigurement at the seat of operation, and the importance of the structures lying in this course.

The Anatomical Points.—The bony landmarks that skirt the abdominal wall are each important, and their individual significance should be well. understood. The external oblique muscle is aponeurotic below a line extending between the anterior superior spines of the ilia, a fact which if unknown may lead to confusion in the identification of the respective tissues. The linea alba is broad above the umbilicus (Fig. 902) and narrow below (Fig. 903). The borders of one or both recti muscles are usually exposed in a median incision below the umbilicus. The pyramidalis muscle may be absent on one or both sides, double on one and absent on the other, and often greatly developed on either or both sides. The notch at the upper border of the pubic junction is the bony guide to the median line at that situation in the normal pelvis. The linea semilunaris lies at the outer border of the rectus abdominis, and extends in a curved direction from the tip of the ninth costal cartilage to the spine of the pubis, and opposite the umbilicus it is usually about three inches from the median line in the normal adult abdomen. However, if the cavity be distended, the distance is increased, as also are the width of the linea alba and the space between the recti below the umbilicus. The differences in direction of the fibers of the muscles composing the abdominal wall and the presence of associated fasciæ, the opacity and density of the fascia transversalis, the loose fatty texture of the subserous tissue, and, if normal, the translucent and vascularized peritonæum, should each be noted for obvious reasons.

It is a noteworthy fact that important anterior branches of the dorsal

and lumbar nerves run obliquely downward and forward between the mus-
cular planes of the abdomen which they supply, and that their severance is
followed by a greater or less loss of power of the muscles to which they are
distributed. Therefore, when possible, the abdominal incision should be so
directed as not to expose the patient to the localized loss of power and her-
nial sequels incident to the division of those nerves. *Kelly* calls attention
to the presence in the subcutaneous fat, at a point about an inch above the
pubis, of a small transverse artery; also to one or more veins of considerable
size, frequently found (80 per cent) lying on the peritonæum, behind the
lower third of the linea alba. The latter vessels empty into the vesical
plexus and are denominated by Kelly " the cœliotomy veins." Each of these
vessels should be promptly and efficiently tied, when divided, to prevent the
persistent bleeding that results from the fact of their free anastomoses.

The Preparation of the Patient.—The details of the preparation of the
patient and the preparatory technique already stated (pages 7 and 113
et seq.) should be carried into effect with scrupulous care. The bladder
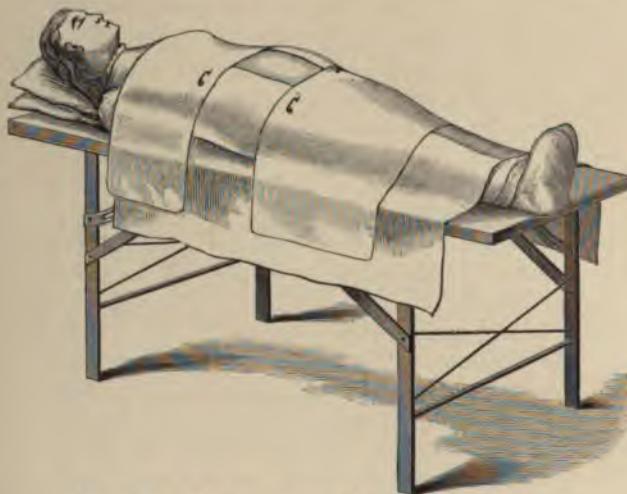
Fig. 899.—Patient prepared for abdominal section.

and alimentary tract should have been emptied some time before the
operation.

Cushing and Livingston * have demonstrated in no uncertain way the
importance of lessening the amount of and rendering as innocuous as prac-
ticable the contents of the bowel in advance of operative procedure upon the
intestines and stomach by means of suitable sterilized subsistence. *Miku-
licz* † in a recent lecture demonstrated the great practical significance of
establishing an artificial hyperleucocytosis in the peritoneal cavity in
advance of infective operations upon the alimentary canal by injections
of albuminose, bouillon, nucelic acid, etc. Twelve hours after these injec-

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* Johns Hopkins Hospital Reports, vol. ix.   † The Lancet, London, July 2, 1904.

tions (subcutaneous and intraperitoneal) the resistance to infection was increased twelve and sixteen fold in some instances. The reported operative outcome under these conditions certainly merits the closest consideration.

The patient is placed on a well-drained, narrow table of convenient height and suitable mechanism, with the trunk and limbs outside the operation field well protected with warm, dry, aseptic clothing (Fig. 899). After thorough cleansing, the abdomen is surrounded with antiseptic towels, and the immediate surface itself is covered with antiseptic gauze until the beginning of the operation (Figs. 166 and 899). *Turck* employs a sheet of thin rubber instead (Fig. 900).

The Operation.—Often the incision is made in the median line below the umbilicus (Fig. 1101). The character of the respective tissues is studied as soon as each is divided, in o r d e r to determine its individuality and the presence of the peritoneal tissue at once (Fig. 902). Aimless manipulation and unnecessary stretching of tissues should be condemned. Arrest hæmorrhage, seize a limited part

FIG. 900.—Turck's thin rubber protective with exposure for incision.

of the peritonæum with thumb forceps, ascertain if it be free from subjacent tissue, then with a knife or scissors snip the portion grasped close to the point of seizure sufficiently to admit the entrance of air and the introduction of scissors for the purpose of further division. When adequately incised to permit, pass a curved needle armed with a strong silk thread through the entire thickness of each border of the wound, and tie the threads in the form of loops (Fig. 51, vol. i). These silken loops not only serve as traction loops, but they also prevent the stripping and displacement of the peritonæum from the adjacent tissues.

Abdominal incisions are now often differently located than formerly, with the idea of obviating as far as possible the sequels—disfigurement and hernia—that are emphatic parts of the record of median incision. With the view of lessening the occurrence of the latter infliction many operators carry the median incision to the right or left, as the case may be, so as to invade the rectus muscle, in a greater or lesser degree, and certainly with improved results. That the fibers of this muscle and the posterior part of its sheath offer substantial support to underlying vulnerable points not possessed by the median line under similar circumstances seems to be fully established.

Künster, with the idea of hiding the scar and limiting the occurrence of hernia in instances of exploration of the lower abdominal region, made a long horizontal incision with the concavity upward, just above the mons veneris, through the hairy area down upon the fascia. The upper and lower margins of the wound were dissected from the sheaths of the recti muscles, the median line being disturbed or not as suited the requirements of the case. The abdomen was then opened through a vertical incision at the side best suited for the purpose of the procedure. In this manner the

FIG. 901.—Instruments employed in abdominal section.

a. Scalpels. *b.* Forcipressure. *c.* Scissors. *d.* Thumb forceps. *e.* Needle forceps. *f.* Tenaculum. *g.* Blunt retractor. *h.* Needles. *i.* Traction loop. *j.* Silkworm gut. *k.* Chromicized catgut. *l.* Silver wire. *m, n.* Broad and hooked retractors.

liability of hernia was lessened and the scar was hidden by the hairy growth and the abdominal fold at that situation.

Pfannenstiel through a similar superficial incision divided transversely the sheath of a rectus muscle, then opened vertically the peritoneal cavity through the rectus and the underlying structures, thus bringing the incision in the sheath of the muscle at a right angle with the line of section of the deeper tissues, thereby maintaining the structural integrity of the parts

in a substantial manner.   An incision through the median line is less
reliable than the preceding one.

The Comments.—It is obvious that these latter incisions afford less
room for general exploration of the abdomen, and are much less suited for
general drainage requirements than the vertical openings into the abdo-
men.   However, for examination and treatment of the conditions referable
to the lower part of the abdomen they afford suitable opportunity.   Pfan-
nenstiel has practiced his method 51 times, Cumston 247 times, Menge in
32 cases, and Stimson in over 150 cases; all with favorable outcome.

The Precautions.—Notwithstanding the fact that extreme cleanliness
should be practiced in all operative procedures, in those directed to the
serous surfaces the vigilance and forethought of the surgeon should be of
the highest order to prevent the possibility of infection.   All matters relat-
ing to the operating room (page 8, vol. i), the preparation of the patient, of
the assistants, and of the surgeon himself (page 113 *et seq.*, vol. i) should
be considered and made to conform to the accepted standard of require-
ment of the time.   In the event of the presence of visitors, those coming in
close relation with the patient should be suitably attired and not have been
in recent contact with infecting agents or diseases, nor should they meddle
with contiguous objects.   A safe rule of action is to keep unemployed hands
in the pockets and avoid textile contact with others unless properly clothed
for the purpose.

The Remarks.—The seat of the incision is determined usually by the
location and outline of the morbid process to be treated.   The length of the
incision is a matter of great importance, for if too short, observation and
manipulation by the surgeon are hindered, and the gravity of the procedure
is enhanced because of the delay and damage arising from inadequate in-
cision.   If too large, needless exposure and escape of the abdominal contents
will happen.   Both primary and exploratory excisions should be made short
at first, and be increased thereafter or changed in direction as circumstances
require.   In long incisions Kelly prefers division through the umbilicus,
avoiding the suspensory ligament.   In closing the wound in these instances
he splits the umbilical tissue at either side to afford broader surfaces for
approximation.   Considerable time is taken by some operators in entering
the abdomen, owing not infrequently to a want of confidence in their knowl-
edge of anatomy and the fear of a precipitous entrance into the cavity.   If,
however, the primary incision be accurately located, and the succeeding tis-
sues be divided directly downward in the same line, the deeper fasciæ and
the peritonæum being in turn picked up at either side with forceps and
raised, and the division made between the forceps, a prompt and safe en-
trance is easily accomplished.   In the instance of adhesion between the
parietal peritonæum and that of the subjacent viscera great caution must be
exercised to avoid cutting the latter.

In those cases in which the contents of the pelvis and lower abdominal
region are to be examined and treated, the elevation of the hips (Trendel-
enberg's posture) for a short time before and during the operation aids
materially in the exposure of the parts, causing the intestines to retire
upward toward the diaphragm.   A further need of their withdrawal may be

secured by the employment of retaining pads of aseptic gauze. If diffi-
culty in breathing ensue or danger of the spread of infecting agents be
enhanced by reason of the posture, it should be employed only with caution
and in a limited degree. The rolling of the patient to one side, away from
the seat of the disease, by means of mechanical adjustment of the table
or by the hands alone, also favors examination of the affected site. The
careful employment of broad retractors and the use of a strong natural or
artificial light are essential to the attainment of intelligent and efficient
observation and treatment.

Adhesions are treated according to their density, length, vascularity, and
the nature of the adherent surfaces, etc. If fragile, they may be readily
torn by the finger or a sponge; if dense, they should be cut; if vascular,

FIG. 902.—Arrangement of tissues corresponding to the upper three fourths of the
rectus muscle (above the semilunar fold of Douglas).

they should be tied before or after cutting, according to the size of the
adhesion and of the bleeding point. The actual cautery may meet the indi-
cation, in some instances, for the arrest of oozing that has resisted adrene-
lin, pressure, etc., but the cautery ought to be used sparingly on account
of its devitalizing influence. Strongly adherent parts of non-malignant
growths may be left attached to an important viscus, especially after the
adherent part has been reduced to a minimum by careful cutting or scrap-
ing. The serous covering of viscera, especially of the intestines, stomach,
etc., should be treated with great care, otherwise this membrane will be
stripped off, possibly destroying the nutrition of the wall at a circumscribed
point, thus causing a slough, followed by peritonitis and death, or a per-
sistent fistula. Surfaces thus exposed may be repaired with omental grafts
or inversion and union of the serous borders with sutures, or by union of
serous surfaces to them. Adhesions may be so dense as to be irremediable.
Omental adhesions can be readily stripped or tied off as their condition
suggests.

The prevention of adhesions between serous surfaces and between serous
and other surfaces, especially in abdominal surgery, is a matter of much
practical importance. Gentleness of manual and instrumental contact and
avoidance of chemical irritation of serous surfaces, is of great importance
in obviating subsequent adhesion. The separation of apposed raw surfaces
or the covering of a raw surface with omentum or peritonæum or by a
serous-covered viscus is usually a salutary means of forestalling adhesions,
at least those of a more objectionable nature. The application of an insol-

uble substance (bismuth) or of the Cargyle membrane for the purpose is apparently of no practical value.

The Precautions.—In omental oozing it is a quicker and securer method of practice to ligature and remove the omentum (Fig. 1297) containing the bleeding area at once than to catch and tie separately the bleeding points. Adhesions should be dealt with under direct observation when possible, in order to note the presence of any ill effect from their rupture. It will be necessary for this purpose, in many instances, to spread out the adherent mass as much as possible before attempting the separation, which can then be done safely with scissors in the instance of fibrous bands.

Hæmorrhage.—The occurrence of persistent bleeding before or after the closure of the abdominal wound is often a complication of profound significance, especially in the latter instance. If all bleeding points be tied at once and oozing be arrested the dangers of this complication are reduced to a minimum. It is wise to restore the patient to the normal dorsal position, and perhaps to permit the return of the viscera to their normal relations in order that the influences of posture and warmth on their circulation may be estimated, and that any threatening outlook may be anticipated and remedied before the final closure of the abdominal wound. If hæmorrhage happen afterward, prompt exposure of the field of operation, removal of the blood clots, and arrest of hæmorrhage is indicated. In such cases as these indecision and contentment on the part of the medical attendant contribute greatly to fatal issues.

The Cleansing of the Peritoneal Cavity.—Blood, urine, bile, fecal matter, diseased and septic products, etc., should be removed from the peri-

FIG. 903.—Arrangement of the tissues corresponding to the lower fourth of the rectus muscle (below the semilunar fold of Douglas).

toneal cavity, when possible, with scrupulous care. While a considerable amount of blood may be absorbed and prove harmless under favorable circumstances, yet even the smallest amount may become the source of septic infection, especially if infecting influences be already present in the abdominal cavity. Flushing, wiping, and drainage, are the common expedients employed for cleansing purposes. An abundance of the hot saline solution (six tenths of one per cent); a weak solution (1 to 1,000) of corrosive sublimate or of carbolic acid (1 to 100); Thiersch's fluid (page 61, vol. i); a solution of peroxide of hydrogen, hot sterilized water, etc., have each been used for the purpose of flushing. However, the employment

of the bichloride, of carbolic acid, and of peroxide of hydrogen, and similar
solutions, is not now regarded with favor (except as a local application to
limited infection), because of the proved deleterious effect exercised by anti-
septic solutions of them on the serous membrane at large, rendering it more
vulnerable to septic influences. The hot saline solution is generally em-
ployed for this purpose, not only because it is harmless *per se*, but also
because it combats infection directly by its osmotic and hyperleucocytotic
properties. *General flushing* should not be practiced for circumscribed in-
fection, since this infection can be well treated by wiping and local flush-
ing; and, too, the former plan of action will cause the dissemination of the
infective material. General flushing must be practiced with great discre-
tion and with reference to the demands of individual cases, for, as Treves
wisely remarks in reference to it, "It is quite as possible to do too much
as to do too little." In general flushing, the borders of the wound are held
upward and apart, and the fluid at proper temperature is poured freely
upon an intervening hand into the cavity and allowed to flow out unhin-
dered until it escapes unchanged in appearance. The cleansing effect of
the fluid can be increased by agitating the abdominal contents with the
hand, supplemented with alternating brisk pressure upon, or shaking of,
the contents by external manipulation. If the patient be then turned to
one side and held there cautiously for a brief time, nearly all of the fluid
will escape. Finally, the portion remaining is caused to gravitate into the
pelvis by raising the body upward to a proper angle and retaining it there
while the fluid is removed as fast as it collects by careful sponging or
siphonage. In so doing it is wiser to introduce a large sponge, which is
removed as soon as it is well filled, squeezed, and again returned, as less
friction will attend this plan than that of the repeated introduction of
small sponges.

If infectious extravasation have occurred, the abdominal wound should
be made large enough to afford prompt inspection and removal of the injuri-
ous agents, as the hindrance, delay, and imperfect opportunity for manual
action in the presence of a small opening do much to prejudice the recovery
of the patient. In these cases when feasible the intestinal folds should be
raised and the hidden recesses carefully wiped or lightly flushed and wiped
to remove concealed infection. It should not be forgotten that vigorous
flushing or repeated sponging or wiping with any agent exercises a trau-
matic effect on a serous surface, and, therefore, increases its vulnerability to
sepsis. Wiping should not be hastily or needlessly employed. It is rare, in-
deed, in general septic peritonitis that general flushing can be properly
practiced. The intestinal distention so common in these cases causes not
only a prompt protrusion of the bowel through the smallest opening, but it
likewise obstructs the introduction of the fluid and prevents the flushing
of the infected surfaces. We know of no way of accomplishing thorough
cleansing in this condition except it be by the removal and rinsing of the
intestines outside of the body. Although by a course of this kind the intes-
tines and abdominal cavity can be thoroughly cleansed, still, the return and
retention of the overdistended intestines will be practically impossible
unless their contents be discharged through free incisions at isolated points,

which are closed at once by intestinal suture, a line of action which should be regarded as more vigorous and protracted than wise in the great proportion of such cases. *Localized flushing and wiping* is easily accomplished, owing to the fact that the infective influences can be quite well circumscribed by a wall of aseptic gauze or sponges. *Wet wiping*, instead, will suffice in the majority of instances. The cautious surgeon should anticipate the escape and spread of infecting material when possible by the establishment of a preliminary aseptic " walling off " with gauze.

The Comments.—The temperature of the saline solution should be about 112° Fahr., and the fluid should be poured carefully from a pitcher and directed in the proper course by the hand of the operator. The use of the hand in this connection is especially important, as the fingers can be more safely introduced and carried between the intestines than can inanimate objects; and, moreover, an improper temperature of the fluid is thus quickly noted. Still, the fluid can be discharged satisfactorily into out-of-the-way places, through perforated, straight, or curved smooth glass or rubber tubes.

The serous fossæ associated with the cæcum, the kidneys, the beginning of the jejunum, the rectum, etc., need careful attention to determine the presence in them of infection, especially in instances of extended contamination. The leaving behind more or less of the saline fluid in the intestinal folds for the purpose of facilitating the resumption of their normal functions and the prevention of adhesions, and thus obviating their prospective entanglement, is often advised. *Wegner* proved that in animals the peritonæum is capable of absorbing from 3 to 8 per cent in an hour of the weight of the body of saline fluid. If this be true of the human economy, then indeed one can estimate the promptness of the disappearance and the probable benefit derived from the pint or more of saline fluid so often introduced into the peritoneal cavity for other purposes than the benefits of osmatic action.

The Drainage of the Peritoneal Cavity.—If the surgeon could be assured of the absence of infection and of the nonproduction in the peritoneal cavity of irritating products, drainage could be dispensed with. Owing, however, to the difficulty of removing from the peritoneal cavity the infectious elements incident to the presence of pus, putrid fluids, etc., and the liability of the production of fluids from injured surfaces in excess of the power of absorption and elimination, it is wise to forestall possible disaster or subsequent reopening of the cavity by the employment of adequate drainage. If one be in doubt regarding the advisability of drainage, then, indeed, it should be practiced, as but little harm can arise from the proper use of suitable drainage agents as compared to that resulting from their need. Textile fabrics, rubber tissue, rubber and glass drainage tubing are the agents in common use. Rubber and glass tubes serve, except when dependently placed, to collect the discharges rather than to conduct them from the wound: however, when thus gathered the discharges are removed by suction with a small syringe armed with a small rubber tube. Not infrequently textile fabric is introduced into, or unwisely around, a glass drainage tube (Fig. 904), thereby substituting for the syringe the influence of capillarity,

and thus lessening the dangers of infection from without. However, rubber dam and glass tubes drain better, at a proper angle, than cigarette and textile-fabric drains, and in textile fabric with either, avoid textile-fabric contact with the peritonæum. In all instances the drainage agents should be carried to the bottom of the most dependent parts, as superficial drainage alone is both deceptive and ineffectual. Antiseptic candle wicking and strips of gauze, surrounded by unperforated rubber tissue, are useful for the purpose. It should be emphasized that the *packing* of a wound with

Fig. 904.—Perforated glass tube containing and unwisely surrounded by textile fabric.

gauze hinders rather than facilitates the escape of the discharges; therefore, the drainage agent should be arranged loosely and carefully in as direct a manner as possible from its beginning to the external surface of the body. This variety of drainage can be inserted between the intestinal folds in various directions. In order that the wound be not infected from without on account of the drainage agent, the external opening must be carefully closed or covered with aseptic gauze or cotton during the intervals of cleansing. The syringe and tube, too, should be carefully guarded against contamination. Ordinarily, drainage can be dispensed with in two or three days.

By this time, in most cases, the intervention of fibrinous products caused by serous contact with the drainage agent will have reduced the efficiency of drainage at the original site to a minimum. Whether or not the foot or head of the bed should be raised in instances of drainage in peritoneal infection is a matter not yet finally settled.

Muscatello determined that normally fluids and foreign particles in the peritonæum of animals are removed upward toward the diaphragm regardless of the posture of the creature. However, gravity greatly favored or retarded the flow as the case might be. With the idea of lessening the possible effect on the patient of rapid absorption of infection incident to elevation of the foot of the bed, *Fowler* advises and many others commend that the head of the bed be raised, with which latter course we are disposed in proper cases to agree. However, it is not to be overlooked that undue elevation of the head of the bed in depressed patients may be quickly followed by symptoms of circulatory failure. Therefore when feeble patients are thus placed urgent attention should be given them to obviate an ill effect hardly justified by the practice of a yet not thoroughly settled measure. *Murphy* commends the sitting posture in operative practice and in after treatment of cases of this nature. Here, too, is afforded abundant opportunity for the exercise of wise discretion. The drainage agents should be as limited in number and size as may be consistent with the demands,

and they should be placed, not packed into position, and should be removed as soon as practicable.

The Remarks.—The absence of organisms in the field of operation, as determined at the time by the microscope, self-evidently contra-indicates drainage. *Kelly* often omits drainage in gynæcological cases, even in the presence of a small number of germs, with satisfactory outcome. Latterly the practice of closing the abdominal cavity without drainage in septic cases is advised with apparently justifying results. That closure in such cases in many instances is better practice than persistent meddlesome flushing and irrational drainage of this cavity is true. But the nature and the extent of the infection and the vulnerability of the patient to it, are matters for careful thought in this connection before final action. When for any reason the circulation of the intestines is impaired, interfering with their powers of absorption and elimination, the employment of drainage is advisable, and especially in the presence in the peritonæum of infecting agents. Pieces of gauze fifteen to twenty inches long and two or three inches wide, so folded, with the edges inturned and sewed, as to prevent raveling, isolated by rubber dam, are suitably constructed drainage agents for this purpose. These drains are made of plain or sterilized and principally of iodoformized gauze. In the latter it is wise to wash out the excess of iodoform with sterilized water before introduction. One or more strands of wicking makes an admirable drainage agent.

The late Dr. Van Arsdale expressed great appreciation of the drain made of plain gauze saturated with sterilized oil, claiming for it a high degree of absorptive power, easy introduction, and safe and comparatively painless removal. The surrounding of textile-fabric drains with aseptic perforated rubber tissues prolongs their efficiency and facilitates their removal. Pieces of this tissue loosely rolled are especially serviceable, and are easily removed because of little adherence to the serous surfaces. The introduction into the abdomen of a drain should be done in a manner best designed to facilitate drainage and to favor easy and safe removal of the drain. The aggregate of the textile fabric employed is regulated by the size of the area to be drained and the prospective amount of the discharge. Packing the wound hinders proper drainage and ought not to be done except to control hæmorrhage.

The drainage agents should extend from the infected parts by the shortest practicable routes to without the abdomen. If the infection be extensive the number of the drains should be increased and allowed to escape at different aspects of the abdominal wall, usually at the sides. In all instances, where practicable, dependent drainage should be established. The outer ends of the drainage agents and the openings transmitting them are a constant menace to asepsis; therefore they should be protected by an abundance of gauze which will at the same time aid materially the functions of the drains themselves. The overlying gauze should be changed as soon as it is wet with the discharges.

The Precautions.—Gauze drains, especially the iodoformized, should be twisted quite vigorously to the right and left until loosened before withdrawal is attempted, and even then the removal is often quite painful. When

gauze packing is employed to arrest hæmorrhage it should be introduced first around the outer border of the bleeding area, thence toward its center, thus permitting of its easy removal from the center toward the periphery. *Iodoformized drains especially should not be placed in contact* with the ligatures or lines of delicate sewing, because of their tenacious adhesion to contiguous structures and the consequent liability to hæmorrhage and tearing on removal. Ordinarily the need for drainage is met in two or three days, when the agent should be removed, for delay provokes increased discharge, exposes to infection, causes ulceration, and lays the foundation for sinus formation, intestinal obstruction, and hernial protrusions. The threads liable to detachment from a drain should be removed and the borders turned in and securely sewed, otherwise they will become detached from the drain and remain in the wound, causing abscess, and perhaps fatal sepsis.

  The Closure of the Wound.—A thin, wide sponge or broad gauze " wiper " (Fig. 73) should be placed on the abdominal contents before closing the wound, to prevent the escape of the intestines and absorb such fluid blood as may come in the way. Two methods of closure of the borders of the wound are practiced: 1, in which certain tissues are joined independently with each other—i. e., tier suturing (Fig. 905) ; 2, in which the borders are joined as a whole, sometimes called suturing *en masse* (Fig. 908). *In the former* the serous and fascial tissues may be united independently with continuous sutures, then the subcutaneous fat, and finally the integument are similarly united, thus introducing four lines of sutures; the number can be increased or diminished as suits the surgeon. *In the latter* method the borders are transfixed with a long needle carried at either side from within outward, therefore requiring a needle at each end of the suture. Although this plan of introduction is the better one, still, the transfixion is oftener made from right to left, or the reverse, with a single needle, the first border being pierced from without and the last from within, both including, perhaps, the peritonæum of the respective sides. The requisite number of sutures—about three fourths of an inch apart—should be placed before any are tied, unless the wound be a long
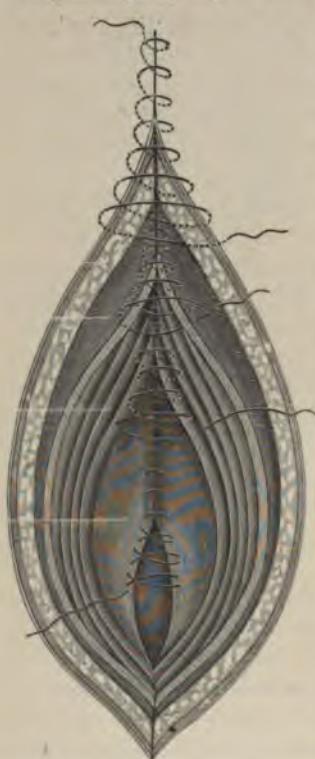
Fig. 905.—Tier suturing.

one and the tendency to intestinal protrusion be pronounced, then one or more of the upper sutures should be tied at once to reduce the size of the opening. The final outcome of the two methods of procedure is of obvious importance. In the first method less than six per cent experience hernial

protrusion; in the latter a greater number (ten per cent) are said to suffer sooner or later from this infliction.

The Comments.—In either method of sewing, space should remain, when needed, for the exit of the drainage agent, which is usually placed at the most dependent part of the incision. The sutures should be tied from above downward, the sponge or gauze being removed while sufficient opening yet remains for its exit. The air within the peritoneal cavity should be expelled by pressure before complete apposition is made of the peritoneal borders. Silkworm-gut, silver-wire, catgut, and silk sutures are used according to the fancy of the surgeon, the first two being preferable in most cases of heavy sewing. A close apposition with each other of the divided borders of the respective tissues is essential to the final security of the line of union.

FIG. 906.—Tier suturing, transverse section, dead spaces caused.

FIG. 907.—Suture *en masse*, peritonæum sutured independently.

Catgut sutures are commonly employed in sewing the peritonæum; silver wire or chromicized catgut in sewing the fascial and aponeurotic tissues; chromicized catgut or silk the muscular; catgut the adipose, and silkworm-gut or catgut the cutaneous tissues. The mattress (Fig. 920) and subcuticular sutures (Fig. 1331) are suited to the fascial and subcutaneous structures respectively.

The Precautions.—The borders of the fascia retract considerably on division, and may therefore escape notice and remain ununited, thus contributing greatly to serous adhesions and hernial sequels. The borders should be secured and carefully united with each other in order that firm union shall be established. The bleeding points of the subcutaneous fat especially should be looked for and securely arrested to avoid subsequent flow and the formation of hæmatoma and its sequels. The liability of forming "dead spaces" (Fig. 907) by incomplete coaptation of the divided borders of the abdominal tissues should be carefully guarded against.

The Treatment of the Wound, etc.—The wound is cleansed and several layers of sterilized gauze, large enough to extend four or five inches beyond the borders of the incision, are applied. Silver-foil films are directly applied and held in place with gauze and adhesive strips in subcuticular sewing (Halsted). Abundant layers of sterilized cotton or "combination" (page 108) are placed over the primary dressings. The whole is confined firmly in place by means of a single broad body bandage, pinned in place (Fig. 906), or by one of the many-tailed pattern. In either instance the lower borders will slip upward unless confined by means of perineal straps. The binder is applied, having an opening for the end of the tube, the tube is protected by absorbent cotton, and the patient placed in bed. Bottles or

53

other receptacles filled with hot water and carefully surrounded with flannel are placed at the patient's side and between the limbs, if circumstances demand their use.

The After-treatment.—The patient is kept quiet on the back, thirst is relieved by sips of hot water and hot saline enemata, the bladder is emptied with a catheter, light food is given, the temperature and pulse are recorded, and otherwise carefully watched. Constipation is treated with salines and enemata, and flatulence, with carminatives and the rectal tube. Unless specially indicated the wound is not dressed till the fifth or sixth day, and again in two or three days thereafter, at which time the stitches are removed, and, if need be, the abdomen is supported with strips of adhesive plaster and a binder. The bodily comfort of the patient should be considered from the outset by encouraging change of posture in bed, the use of baths, and fresh linen. The patient is permitted to get up at about the end of the fourth or fifth week, and for some months thereafter an abdominal supporter may be worn, especially by fleshy patients.

Fig. 908.—Body bandage pinned in place.

The General Comments.—The opening in the peritonæum should be made small at first, only large enough perhaps to admit the index finger; later, however, it should be increased to meet the demands of explorative and operative technique, without unnecessary delay or the employment of undue force. A large sponge introduced into the pelvis, and numerous small wipers placed at the borders of the operation field, will absorb the fluids associated with the operation, and additionally the latter should prevent the escape of the intestines and their contact with deleterious agents. Injury to the ureter, intestine, gall bladder, etc., should be carefully avoided, and when inflicted prompt repair should be practiced.

The Fallacies.—The aponeurosis of the external oblique may be mistaken for fascia, and consequently the internal for the external oblique, and so on, causing much anatomical confusion. The transversalis fascia may be mistaken for the peritonæum, and, therefore, the subserous tissue for the omentum, and possibly the gut for the peritonæum itself; and especially is the last fallacy liable to present if the intestine be adherent to the parietal peritonæum. The number of the sponges and all other agents employed in direct connection with abdominal section should be accounted for before the wound is closed (see italicized expression, pages 93 and 94,

vol. i), otherwise they may remain behind in the cavity and lead to fatal results. The bladder may be unexpectedly incised if adherent to the wall or filled with urine, hence it should be emptied, and, if a doubt as to its location arise, its limits should be outlined with a sound at the time of operation.

The Results.—The results will be stated in connection with the special objects for which the abdominal section is made.

Explorative Abdominal Section, or Explorative Laparotomy.—The abdominal cavity is frequently opened for the purpose of ascertaining the cause of disease manifestations, and with the view of applying the surgical remedy therefor, if feasible; but if operation is impracticable, the incision is usually promptly closed. The technique of the explorative section differs in no essential manner from that already stated. The incision is usually made over the seat of the trouble.

OPERATIONS ON THE INTESTINES.

It is important in operations on the intestines to observe the following considerations with great care: 1. The avoidance of all unnecessary hæmorrhage. 2. The prevention of the escape of irritating matters into the abdominal cavity. 3. The union of the divided borders so that they will remain properly joined and result in perfect repair. 4. The avoidance of unnecessary shock and of the retention of septic and irritating influences.

The *first indication* is met by the avoidance of incisions through the lines of the established course of vessels, and by the use of needles which do not possess cutting edges.

To meet *the second indication* requires a great degree of care irrespective of the knowledge of any established measures. The lips of the wound should be cautiously guarded by various expedients. If the nature of the case will permit, the contents of the viscus should be removed or pushed aside before the incision is commenced, and at all times the serous surfaces must be protected from contact with irritating matters, by means of broad, thin, aseptic sponges, or pads, moistened in a warm, mild, aseptic fluid.

To fulfill *the third indication,* sutures of various forms and methods of application are employed, the aim of all being to bring the serous surfaces in contact, and maintain them so until firm union is established. When possible, a wound of the intestine, however small, should be closed, to prevent the escape of irritating matters into the abdominal cavity.

The fourth indication is very important, especially if the operation be prolonged and tedious (page 120 *et seq.*, vol. i), or if it be necessary to remove the intestines from the cavity of the abdomen. The room in which operations on the abdominal contents are performed should be thoroughly cleansed and fumigated when possible, and in every way made aseptic. If the temperature can be raised to about 100° F., and the atmosphere moistened with vapor, the surroundings will be much improved, especially for cases in which the abdominal contents are long exposed. If the intestines be removed from the cavity, they must be surrounded by sterile cloths saturated with hot (112° F.) aseptic fluids, preferably the saline solution, and

kept warm and moist by repeated applications of the same or by enclosing the whole with rubber tissue. The introduction into the peritoneal cavity, if expedient, of Turck's resuscitator, kept warm by means of a continuous stream of water at a temperature of 130° F., is an efficient means of managing shock. The " toilet " of the abdominal cavity must be cautiously and perfectly made before closure, and suitable provisions for drainage established if pernicious secondary local processes be apprehended.

Intestinal Sutures.—The varieties of intestinal suture are numerous, ingenious, and effective, but often too complicated to be practicable for the use of others than those who designed them. Our aim, therefore, will be to describe those only that have the sanction of practicability established by experienced use and commendation. Round needles that displace and do not cut the tissues in the passing are employed in intestinal sewing, the common cambric needle being a good illustration of the kind—*the calyx-eyed needle* being the most expeditious. Silk is of accepted use in intestinal sewing. It should be of sufficient determined strength to permit of proper apposition of the surfaces, and colored to enable the operator to define easily the exact location of the sutures. The fine iron-dyed, twisted kind is very satisfactory in these respects. Fine catgut is sometimes used instead of silk, but is much less reliable. Stronger and coarser silk than the preceding is employed in common sewing and in the ligature of vessels. A still greater increase in these characteristics is needed in the ligatures applied to large masses of tissue, pedicles, etc. The braided and cable-twist varieties are the strongest, the latter being of American and English manufacture. The former of these is the weaker of the two. It is to be regretted that the standards of silk are not so definitely classed as are those of wire, for then silk could be ordered with a certainty of return that now can be secured only by the sending of a sample of the desired size.

FIG. 909.—The continuous suture.

The Precautions.—Unless *the strength of silk be tested before it is used* it may break when applied, causing delay and confusion and perhaps impairing the work of the surgeon. Sutures entering from without into mucous-lined cavities, such as the intestines, were formerly thought quite liable to cause infection by capillarity. However, greater experience in this respect demonstrates that the degree of danger has been overestimated, since a closely fitting suture introduced by a needle with a non-cutting surface makes a quite secure union. It is wiser, no doubt, that all except the mucous coats be included in the stitch, and when for any reason the lumen of a mucous-lined cavity is invaded in sewing, that supplementary stitches not thus complicated should be at once introduced for securer union. However, two rows of sutures at the same line of union are liable to cause death of the included tissue, especially when they are drawn tight. The borders of the wound of the intestine should be brought in contact with each other

before transfixion by inturning, as indicated in the illustrations near at hand showing the act (Figs. 914 and 915).

The Cushing Suture.—In this suture the needle does not enter the cavity of the gut, but instead it includes the serous, muscular, and submucous fibrous coats. The sewing is commenced as shown in Fig. 910. The thread
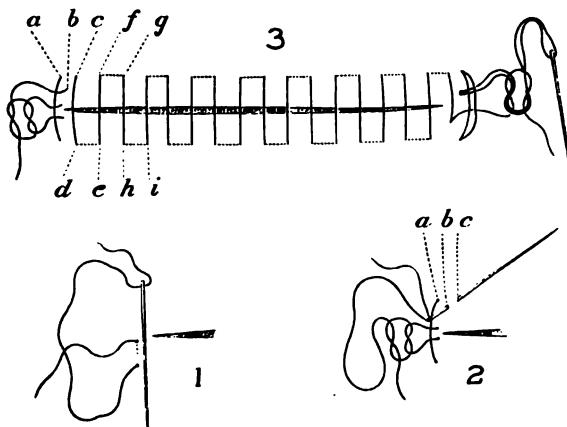
Fig. 910.—The Cushing suture. 1. The beginning. 2. The knotting. 3. Suture applied. *a, b, c,* in 2 and 3, indicate needle punctures. *d, e, f, g, h, i,* indicate track of needle.

is knotted and the stitches are taken in the manner indicated, and when the thread is drawn tight the wound is closed and the suture is buried (Fig. 911). The final tying is illustrated also (Fig. 910).

The Continuous Suture (Dupuytren) (Fig. 909).—The name of the suture defines its arrangement. This form is exceedingly useful in joining
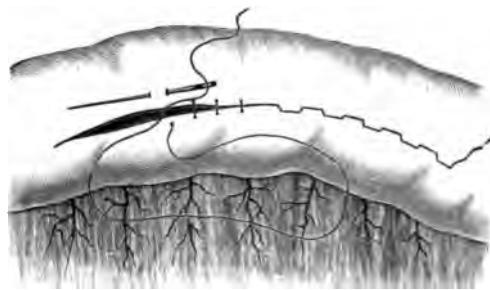
Fig. 911.—The Cushing suture, closing wound.

together the borders of long cuts of either serous or cutaneous surfaces. In the former the stitches are placed closer together than in the latter. When two rows of continuous sutures are introduced, or any other form for that matter, the primary row may be passed through and through, outside or in, provided that the line of sewing be buried by a secondary superimposed row not at all invading the mucous layers. In all forms of sewing much

time will be saved if *the calyx-eyed* needle be employed. This needle can be quickly armed by putting the eye down upon a taut suture. However, it is easily broken at the open eye by the incautious grasp of a needle holder.
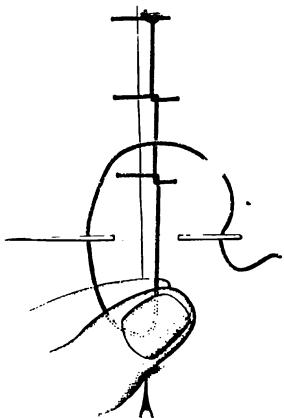
FIG. 912.—The Ford suture, passing needle to tie single knot.
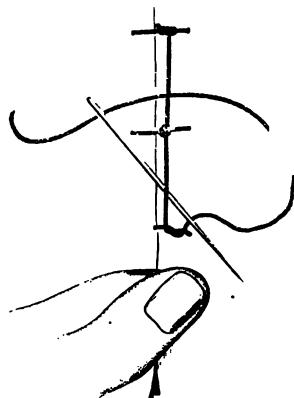
FIG. 913.—The Ford suture, completing square knot.

The Ford Suture.—In the Ford suture the form is continuous with an inversion knot made of a single turn with each transfixion (Fig. 912), the mucous surfaces not being invaded. Also a square knot may be formed (Fig. 913). With this arrangement each suture is more independent of its neighbor than in the simpler form of continuous sewing, hence less liable to shortening and puckering from incautious traction on the thread. We regard this suture better adapted to cutaneous than to serous sewing.

The Lembert Suture.—By this method the serous borders are infolded
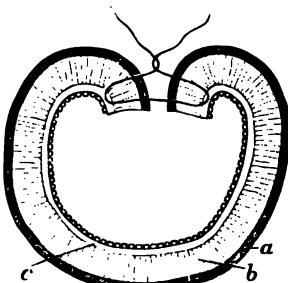
FIG. 914.—The Lembert suture. *a*. Serous coat. *b*. Muscular coat. *c*. Submucous fibrous coat.
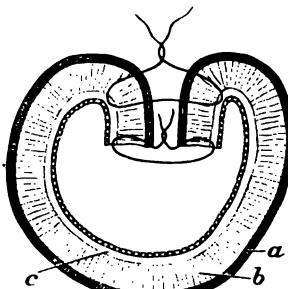
FIG. 915.—The Czerny-Lembert suture. *a*. Serous coat. *b*. Muscular coat. *c*. Submucous fibrous coat.

(Fig. 914) and the sutures are passed through them at about a tenth of an inch from the edges of the wound, being placed about the same distance apart. The number of stitches and the amount of tissue included will be

governed by the thickness of the tissue and the strain exercised.   The
rapidity of intestinal sewing can be increased if four traction sutures be
inserted, two on either side of the divided gut in the line of the tissues to
be stitched.   These pairs of sutures, one at either end, are made tense in
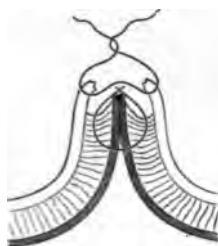
FIG. 916.—The Wölfler
suture, sectional view.
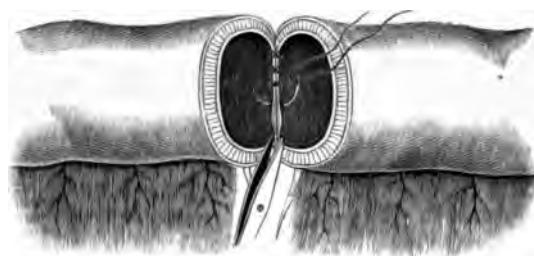
FIG. 917.—The Wölfler suture, joining the mucous and
submucous coats.

opposite directions, thus raising parallel folds of serous membrane through
which the intestinal sutures are passed (Fig. 1007).

The Czerny-Lembert Suture (Fig. 915).—Two rows of sutures are em-
ployed in this method, neither of which, however, is passed through the
mucous membrane.   The first, the deep series, brings the edges of the
mucous membrane together; the second, the Lembert, is passed as before
indicated.   The introduction of the first series is materially aided by the
eversion of the mucous membrane.   After rectification of the walls in end-
to-end sewing, the majority of the knots should be within the bowel; in
the closure of small wounds they are without.

The Wölfler Suture.—Wölfler joins the divided ends of intestine by two
rows of interrupted sutures.   The first, the outer, row includes the serous
and muscular structures (Fig. 916), the second, the inner, includes the
mucous and submucous tissues (Fig. 917).   The sutures are tied internally
throughout except the last few.   The direction of the manipulations in
these latter is reversed for obvious reasons.
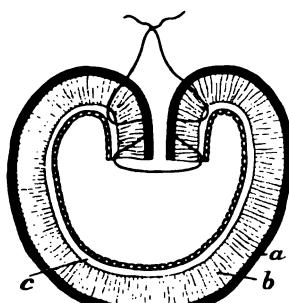
FIG. 918.—The Gussenbauer
suture.
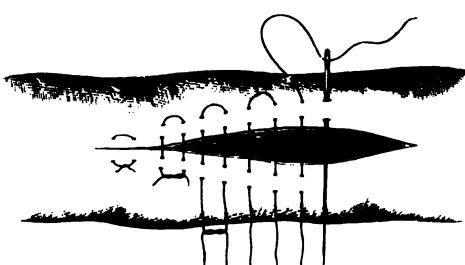
FIG. 919.—The Halsted suture, closure of longi-
tudinal incision.

The Gussenbauer Suture.—By this form of suture the submucous (*c*),
fibrous, and serous tunics (*a*) of the intestine are brought in place at once

(Fig. 918). However, this stitch is complicated and somewhat tedious, and affords no additional security to repay for the slowness of execution and difficulty attending its use.

The Halsted Suture (*Mattress or Quilt Suture*).—The stitches of this suture are of the nature of the Lembert. They are passed so as to include
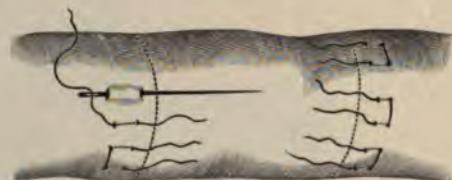
FIG. 920.—The Halsted suture, end-to-end sewing.

some of the tough, submucous fibrous coat (Fig. 915, *c*). Tying should be omitted, when practicable, until all of the stitches are in place.

The Jobert Suture.—Jobert's suture is employed to unite the divided extremities of a bowel. Identify the proximal and distal ends by examination and by Nothnagel's test—chloride of sodium causes reverse peristalsis —dissect away the mesentery for a third of an inch from either end of the gut; transfix the proximal end with one needle armed with a long suture at the site of mesenteric attachment (*a*) and with another at a point in the border opposite to it (*b*) (Fig. 921); invert the margin of the distal end (Fig. 922); introduce two sutures at either side of the proximal end in a similar manner; arm both ends of each ligature with needles, and transfix from within outward the inverted portion at points corresponding to the
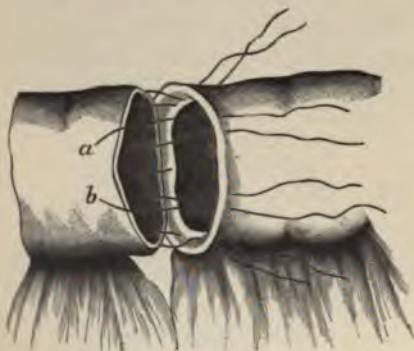
FIG. 921 —The Jobert suture, bringing ends together.
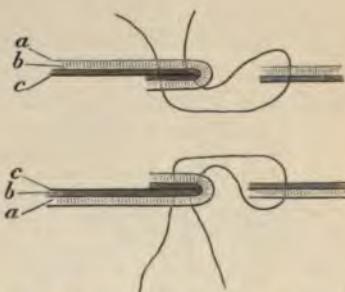
FIG. 922.—The Jobert suture, longitudinal section. *a.* Peritoneal. *b.* Muscular. *c.* Mucous coats.

sites of transfixion of the proximal end; draw the upper end of the bowel into the lower and tie the sutures at the outer side (Fig. 923). When necessary a greater number of sutures may be applied in a similar manner and tied (Fig. 924). This course adds greater security to the union. The application of continuous sutures to the line of junction should be avoided, as the sewing will interfere with the nutrition of the inverted part still

more and increase the danger of sloughing that exists already in a certain degree. An occasional interrupted suture (*a*) may be inserted to strengthen the union.

Senn modified this method in a very important manner. Into the upper end of the bowel he introduced a common soft-rubber band of a
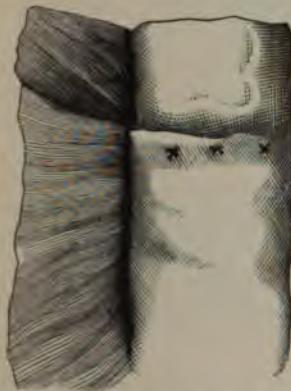
FIG. 923.—The Jobert method, sutures tied.
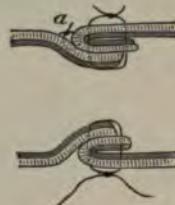
FIG. 924.—The Jobert suture, fixation sutures tied. *a.* Interrupted suture.

length corresponding to the caliber of the intestine and joined it to the margin of the bowel with a continuous fine catgut suture, thus preventing the protrusion of the mucous membrane and causing the end of the gut to assume a tapering appearance. Two fine catgut sutures are then passed from within outward at opposite sides of the bowel, as in the preceding method, transfixing the rubber ring and the wall of the intestine (Fig. 925). Both ends of these sutures are then caused to pass from within outward through the serous and muscular coats of the distal end of the bowel about a third
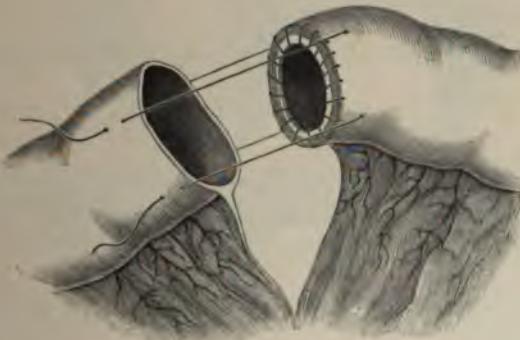
FIG. 925.—Senn's modification of Jobert's suture. Rubber ring sewed in position.

of an inch below the margin. The upper is then drawn carefully downward into the lower extremity by aid of the sutures, while the margins of this latter extremity are cautiously inverted with the aid of a director or

probe. The sutures are tied as before, no additional ones being regarded as necessary. The rubber ring serves the important purpose of facilitating the invagination, of easing the suture tension, and obviating capillary drainage of the sutures themselves. Sooner or later the ring comes away in the natural form. An ordinary rubber band, shortened by tying the ends with catgut, will suffice for the purpose.

The Remarks.—The Lembert, Cushing, and Halsted sutures can be applied by those of comparatively limited experience, and neither of them encourages infection by capillarity. The remaining varieties are more complex and difficult of application, and unless cautiously adjusted are open to the criticism of inviting infection of the tissues because of their association with the mucous lining of the intestine. However, inasmuch as time is an important desideratum in intestinal sewing, the operator ought always to employ the suture with which he is most familiar, provided it meets the demands of proper repair.

Intestinal Approximation.—The approximation of the small intestines with each other and with the remaining hollow viscera of the digestive system in such a manner as to cause a change in the regular channel of transmission of the contents, is a procedure of modern practice. *End-to-end and lateral approximation* (intestinal anastomosis) are the common methods of intestinal operation. End-to-end approximation is done by means of common (Lembert and Halsted) and special suturing with or without invagination, as has been described already (Figs. 916 and 921). In addition to these methods others have been devised which are both prompt and effective, and the result of ingenious conception and patient,
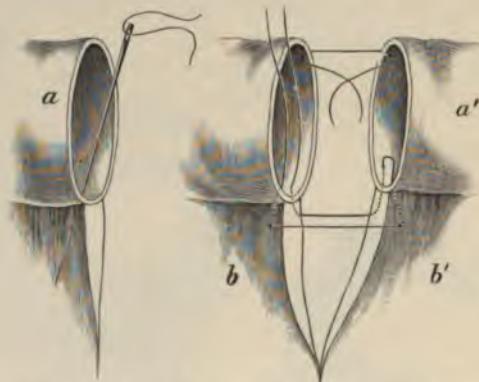
Fig. 926.—Maunsell's method, passing traction sutures.

laborious application. It is possible to describe in this limited space only those in common use.

Maunsell's Method.—The ingenious method devised by Maunsell is entitled to much consideration. The technique of the method is substantially as follows: After carefully freeing the lumen of the bowel of its contents for some distance at either side of the proposed division, and compressing it to prevent return, the field of operation is protected by gauze pads, and the

resection made. The parts are then thoroughly cleansed, the wound in the mesentery is closed, and the proximal and distal ends (a, a') of the intestine are temporarily united with each other by two sutures, the extremities of which are left long. One of these sutures is so introduced from within
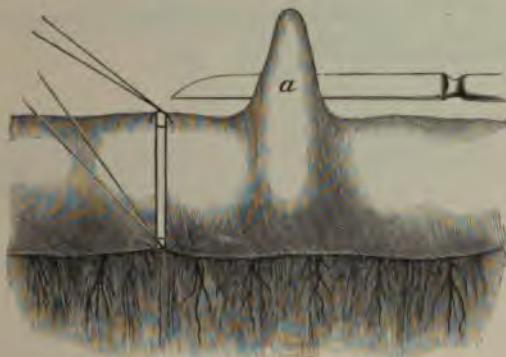
FIG. 927.—Maunsell's method, ends adjusted. Longitudinal slit being made (a).

(a) outward as to include the wall of the gut and the mesentery (b) at that side (Fig. 926), thence is carried across to the opposite extremity (b') and inserted upward and inward through the mesentery and bowel into the lumen, then it goes from within, downward and outward, piercing the tissues as before in the reverse order, finally passes through the mesentery and enters the bowel (b) and at a corresponding point adjacent to that of primary departure (a), leaving the free ends of the suture handily placed for subsequent grasping (Fig. 926). The second suture unites the borders of the intestinal ends opposite to the preceding one in a manner easily demonstrated by the cut.
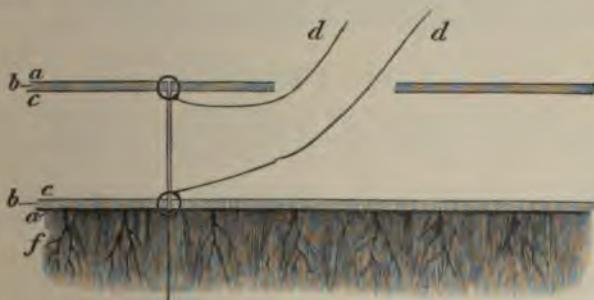
FIG. 928.—Maunsell's method, traction sutures (d, d) carried through longitudinal slit. a, b, c. Mucous, muscular, and serous coats. f. Mesentery.

Both sutures having been tied after a careful adjustment of the borders of the bowel (Fig. 927), a longitudinal slit an inch and a half in length is made through the free border of the larger extremity, about two inches from the end, by means of a scalpel passed upward through a pinched-up portion (Fig. 927, a) of the intestinal wall at that situation. The ends of

the traction sutures carried into the intestinal lumen and out through the
slit by means of forceps (Fig. 928), are now pulled upon (d, d), thus caus-
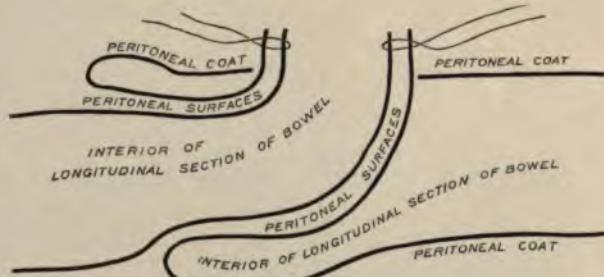
FIG. 929.—Maunsell's method, comparative relations of intestinal surfaces shown.

ing the extremities of the intestinal segments to be dragged through the
opening (Figs. 929 and 930) and to appear above as two concentric rings

FIG. 930.—Maunsell's method, intestinal extremi-
ties drawn through the longitudinal slit; sewing
begun.

of intestinal tissue. While
held in this position by the
temporary sutures, the bor-
ders of the rings are trans-
fixed through both walls with
a cambric needle (a) armed
with horsehair sutures. At
each transfixion the suture is
caught at the middle with for-
ceps, drawn upward, divided
and each half tied, thereby
forming two independent su-
tures. About eighteen or
twenty of these sutures—the
result of nine or ten transfix-

ions—are thus placed (Fig. 932). Finally, the temporary sutures are cut
short, the invaginated ends by gentle traction are reduced, the longitudinal
slit (b) is closed with Lembert sutures, and the operation is completed
(Fig. 931).

Segments of intestine of
unequal size are readily uni-
ted by this method in the
following manner (Fig. 932):
Unite the mesenteric borders
with a suture (a) as in the
preceding instance; transfix
the sides of the larger segment
by a simple suture (b) passed
so as to include the superior
border of the smaller segment,
and tie it, leaving the ends
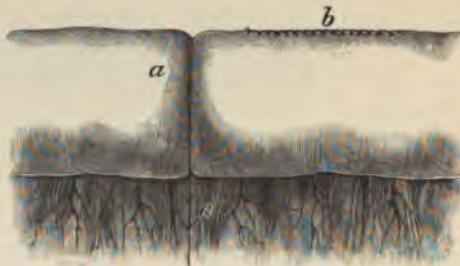
FIG. 931.—Maunsell's method, operation com-
pleted. a. Line of intestinal union. b. Slit
closed. c. Mesentery sewed.

long as before; pass a third suture (*c*) through the walls of the larger seg-
ment of intestine at its highest point (*c*); make a longitudinal incision (*d*)

FIG. 932.—Maunsell's method, segments of unequal size.

at the superior border of the larger segment two inches from the end; pass
the ends of the sutures through it, draw upon them so as to cause the ends of
the segments to appear above the opening, where they are sewed in the man-

FIG. 933.—Maunsell's method, borders sewed.

ner already described, and illustrated (Figs. 930 and 933), after which the
longitudinal slit (*d*) is closed with Lembert sutures (Fig. 934). If the dif-
ference in the diameters of the segments be great, it is better that a V-shaped

FIG. 934 —Maunsell's method, unequal segments, continuity restored.

portion be removed from the superior border of the larger one. After exci-
sion of a portion of the duodenum and of the pyloric end of the stomach
(Fig. 935), the unequal extremities can be united with each other by first
placing traction sutures in a manner similar to that in the anastomosis of
unequal intestinal segments. The long ends of the traction sutures (a, a, a)
are then passed into the stomach and out through a slit made at its anterior
surface (b), through which the divided borders are drawn by the sutures;
the serous surfaces are carefully apposed and sewed, as for intestinal
union (Fig. 930). A movable part
of the duodenum or the jejunum
can be anastomosed with the stom-
ach by this method. A portion of
the greater curvature of the stom-
ach, along with the intestine in
question, is exposed at the abdom-
inal wound (Fig. 936), and the
under surfaces are joined with two
or three Lembert sutures. Corre-
sponding openings are then made
in the apposed surfaces of the vis-
cera, and a traction suture is passed
through the opening of each at the
adjacent angles of the wounds (b),

FIG. 935.—Pylorectomy, Maunsell's method.

and the ends are introduced into the stomach and passed out through a long
longitudinal slit (a) located at some distance above the point of junction, by
means of which the divided borders are drawn upward and out of the supe-
rior incision and sewed, as in the foregoing instances. If the superior bor-
ders of the openings in the respective viscera be united with a few Lembert
sutures, the upward displacement through the opening will be more readily
and safely accomplished and the final sewing greatly facilitated. The pre-
ceding illustrations of the application of this method are an earnest of its
utility in other portions of the intestinal tract to which its technique can
be applied.

The Comments.—The method of Maunsell is easily and rapidly em-
ployed, and is readily available, since its application needs the support of no
special agents. However, it is open to the objections, first, of the possibility
of inviting drainage infection of the peritonæum because of the through-
and-through placing of the sutures, and, second, of liability to subsequent
cicatricial contraction at the line of sewing caused by the ulceration proc-
esses incident to healing. The former objection can be met by a supple-
mentary sewing of the serous surfaces along the line of their junction after
the reduction of the invaginated borders, and by suitable needles and sutures
(page 754 et seq.). It is claimed (Wiggin) that the second objection has no
practical foundation. Always ligature the bleeding points of the mesentery
before resection to obviate gangrene of the border of the intestine there-
after on account of faulty technique.

Connell's Intestinal Suture.—Connell has devised a form of sewing
of the intestine which includes the entire thickness of the walls of the viscus
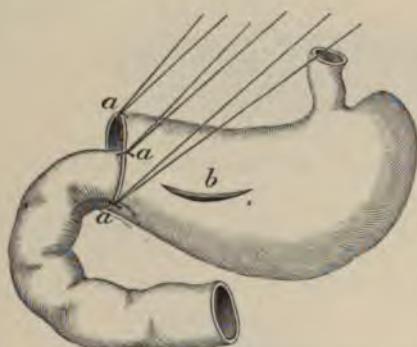
and locates all knots inside of it. The line of union is always reliably strong for this reason, and it has thus far given satisfactory results in all respects. The fact that the infection from sewing of intestine escapes almost invariably at the seat of the knots (Clumski) appears to justify the technique of this form of union.

The Operation.—Close the V-shaped space at the junction of the mesentery with the intestine (Fig. 937, *a*) in the following manner: Pierce at the lower part of the intestine near to its denuded border from within the lumen downward and outward (Fig. 926, *a* and *b*), the coats of the intestine and the serous boundary of one side of the triangular space, with a needle armed with a silk ligature; carry the needle directly across to the apposing end of intestine from without upward and inward into the lumen (Fig. 926, *a*) through the intervening tissues in the reverse order to that first practiced, thus completing the first half of the stitch. The remaining half like the first is indicated by illustration 926, *a*.

After careful adjustment of the parts of the borders included in the stitch, the suture is tied, thus obliterating the mesenteric space, and the ends of the suture are allowed to remain hanging outside the bowel and are known as loop No. 1 (Fig. 937, *a*). Three additional loops are now
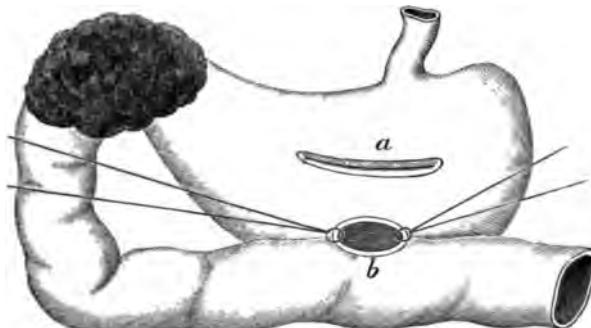
Fig. 936.—Gastro-enterostomy, Maunsell's method.

made in the following manner: Place the divided intestines side by side, the borders of the open ends being exactly even with each other; pass a needle armed with a suture through the four walls of the intestine at about an eighth of an inch from the divided borders and at a point two-thirds of the distance from the mesenteric to the free border of the intestine; draw upward with a hook the portions of the suture within each lumen to a sufficient distance, forming three loops (Fig. 937, *a*) which with the first divide the circumference of the intestine into thirds; tie the loops as indicated (arrows) in illustration *a*, loops 1 and 2 being nearly opposite to each other; grasp and make taut loops 1 and 2, and sew from loop 1 outward the intervening third of the circumference by continuous suture, beginning and ending with a back stitch for greater security; cut and remove loop 2, grasp and make taut, loop 3 and 4 (Fig. 937, *b*) thus bringing into apposition the divided borders of the second third of the
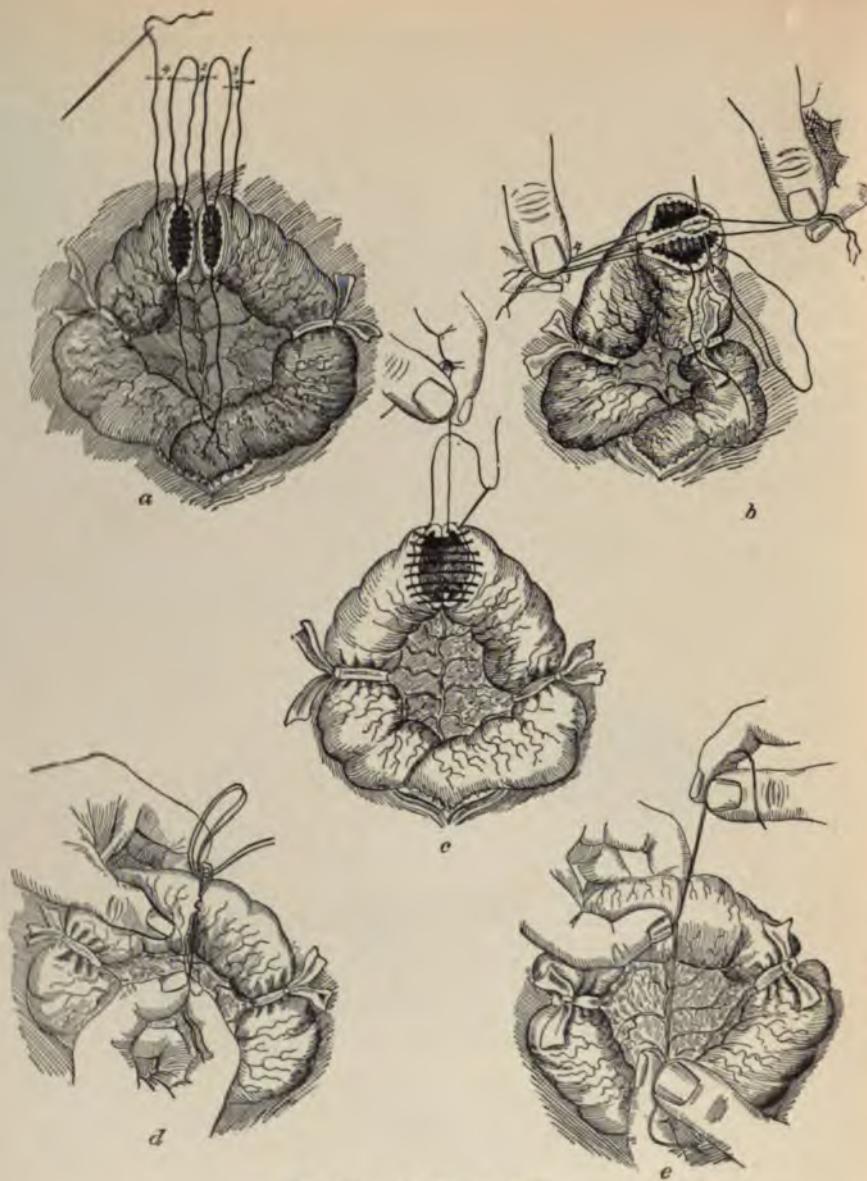
Fɪɢ. 937.—Connell's Method.

a The suspending loops 2, 3, and 4, are made with one thread inserted at a point
two thirds of the distance from the mesenteric to the convex border. b. Loop 2 has
been cut away, and loop 1 takes its place in one hand of the assistant, with loops
3 and 4 held in the other hand, thereby bringing into opposition the portion of
the walls to be included in the second third of the suture. The white elevation
in the center of the illustration, representing mesentery, shows that that portion
of the intestinal wall not covered by peritonæum, at the mesenteric border, has
been secured in the suture. c. The needle, after having entered the lumen, is
passed out again on the same side one eighth inch distant; then over to the opposite
cut end, where it is inserted from without in, and again emerges from within out,
on the same side. d. The eye-end of threaded needle is made to emerge alongside
of the suture ends, and is then withdrawn a little, which causes its thread to form
a relaxation loop, through which the assistant passes the ends of the suture. e. By
slight traction on the suture ends the opposing serous surfaces are brought in close
contact; the suture ends are then tied firmly, deep between the serous coats, thus
tying the knot upon the mucous coat, and the ends then cut off short.

circumference along which the sewing is continued, being fortified by a lock-stitch at its ending. The closure of the remaining third is less easy, requiring greater care and more time than does either of the preceding thirds. In continuing the sewing, pass the needle from without, an eighth of an inch from the border, through the intestine into the lumen, then pass the needle from within at the same side at a point an eighth of an inch from the border, also an eight of an inch beyond the preceding point of entrance; repeat this step, taking alternate bites in the borders of the divided intestine of the respective sides until the required number of stitches have been introduced; observe that the needle on entering the lumen for the last time necessarily can not complete the stitch, and instead is brought out of the angle of the wound by the side of the free end of the ligature (Fig. 937, c); draw carefully into place the stitches just passed, closely apposing the serous surfaces at every point; cause the eye-end of the threaded needle to emerge by the side of the suture ends and withdraw the needle sufficiently to cause its thread to form a relaxation loop through which the assistant passes the ends of the suture (Fig. 937, d); withdraw the needle thus threaded, causing the suture ends to present externally at the point of withdrawal of the needle (Fig. 937, e); tighten the serous coat at the entire circumference by slight traction on the suture ends, tying the latter firmly deep between the serous coats; cut off the ends short, thus leaving the knot upon the mucous surface.

The Remarks.—The technique just described relates to the employment of the continuous suture, which is more quickly practiced than the interrupted, although not regarded quite as secure by Connell.*

Coffey regards the interrupted Connell suture as ideal. He considers the continuous form as objectionable, since it may be found hanging in the intestine even after its introduction. A double line of sutures· going deep in both instances is liable to cause so much interference with the circulation as to expose the included structure to danger from sloughing. The number of the traction loops can be varied, so as to divide the circumference in thirds or halves, as may be desired. Instead of traction guys, Connell commends the mechanical device of Lee † for this purpose. However, the simpler the means the better, and the one most available should be cultivated.

FIG. 938.—The Murphy button. *a.* Spring cup. *b.* Receiving cup. *c.* Wire spring regulating flange *p.* *s.* Stem with projecting springs.

Murphy's Button.—Dr. J. B. Murphy has devised this singularly clever mechanism for the purpose of end-to-end and lateral approximation of hollow viscera (Fig. 938). The button is formed of two cups, one of which is known as the spring cup (a). Each is so constructed as to fit its fellow in a manner that secures perfect and continuous apposition of the serous surfaces of the open ends of the bowel, while at the same time the spring (c) exercises a gentle pressure on the intervening tissue, which is

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* Jour. Am. Med. Asso., October 12, 1901.   † Annals of Surgery, January, 1901.

sooner or later severed by it, thus liberating the button in the intestinal canal. Great care should be exercised in securing a properly constructed button, both as to material and perfection of mechanism. The action of the gastric juice on improper material and the hindrance and delay attendant on defective mechanism often contribute to unfortunate results. In addition to the button, intestinal clamps (Fig. 1006) or other means of controlling the lumen of the intestine should be at hand; also a needle and silk sutures,
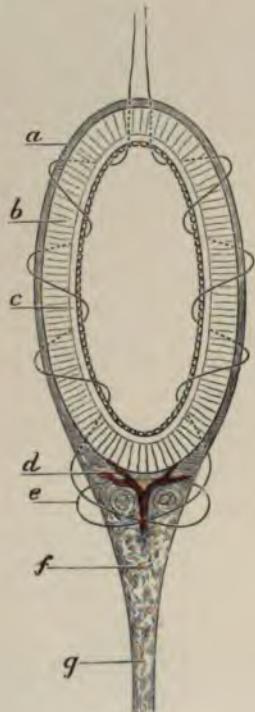
Fig. 939.

Fig. 940.

Fig. 941.

Fig. 939.—Section of small intestine and mesentery. a. Serous coat. b. Muscular coat. c. Submucous fibrous coat. d. Artery to bowel. e. Reverse overstitch and puckering string. f. Triangular space. g. Mesentery.
Fig. 940.—Cup seized for introduction.
Fig. 941.—Spring cup seized for introduction. Spring flange should be pushed down before grasping.

and forceps for grasping the stem of the button. After the necessary cleansing and fortification of the contiguous parts against infection, and the control of the lumen of the gut is effected, a "puckering string" is placed around the free border of the end of the bowel (Fig. 939, e), commencing opposite to, and continuing on one side down to, the mesentery, which is grasped by a reverse overstitch (e), followed by a continuation of the topstitch up the opposite side to the point of beginning. It is noted that if the ends of the suture are left long they may be readily grasped.

One cup of the button is then seized at the stem with forceps (Fig. 940), and is carried into the open end of the intestine and held there, while the puckering string is drawn tightly and tied at the base of the stem. The remaining cup and end of the bowel are treated in a similar manner (Fig. 941), after which the cups are joined and pushed firmly together (Fig. 942). Extremities of unequal diameter can be united in a similar manner to that employed for those of a like caliber.

FIG. 942.—Parts prepared for joining.

For the purpose of making a longer and perhaps more permanent opening between approximated viscera, Murphy devised an oblong button which does not differ in its mechanism and application from the round button in any essential respect (Fig. 943). This variety is sometimes used in lateral approximation of intestines with each other.

Lateral Approximation.—Either the round or oblong button can be employed in lateral approximation; usually the former. The use of the latter is followed by much the larger anastomotic opening, and for this reason, at least, may be regarded the better agent for the purpose. The puckering string in lateral approximation is placed in each instance opposite to the mesenteric attachment, as indicated in Fig. 944. A longitudinal slit is then made in the bowel of sufficient length to permit the entry of the form of button employed. As before, the parts of the button are

FIG. 943.—Murphy's oblong button and key.

grasped separately with forceps, introduced into the respective openings, raised outward, the strings drawn firmly and tied at the bases of the stems. After which the parts of the button are united and firmly pressed together.

The Precautions.—The ends of the puckering strings should be cut short, so that they will not be grasped by the closure of the button, and thus delay its escape. The button should fit the intestine loosely, other-

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wise the pressure of the rim will cause sloughing and perforation. The intestinal contents should be kept in a fluid state, to prevent the plugging of the openings in the button. If the gravity of the agent be sufficient to cause kinking of the intestine and a proper adjustment of the relations be impracticable, another means of union should be substituted.

The Comments.—The use of the Murphy button is open to the rational objection that it introduces into the intestine a foreign body of considerable size, the effect and final escape of which are somewhat problematical. However, the rapidity and ease with which it can be employed, as compared with the longer time, greater difficulty, and absence of general knowledge and experience in the more complicated methods of practice, together with the success attending its use, have established for it a definite and commendable station in intestinal surgery. The oblong button is employed less frequently in lateral anastomosis than are other methods of approximation. In the three instances in which this form was used by the writer, the outcome was satisfactory in all respects.
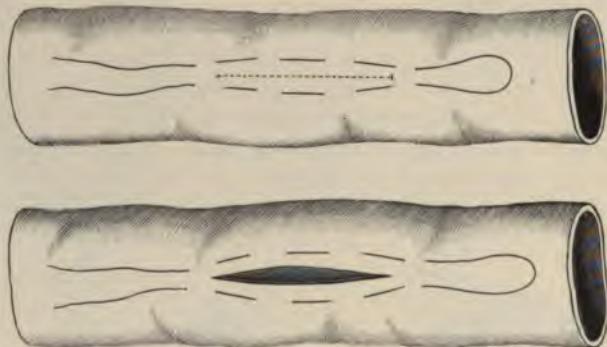
FIG. 944.—Lateral approximation with Murphy's button. Purse-string sutures placed and an opening made.

The Laplace Intestinal Approximation Forceps.—The instrument consists of two symmetrically shaped compression forceps, with semi-elliptical blades, placed in juxtaposition with the concavities of the blades turned toward each other and locked together with a clamp (Fig. 945). When both forceps are locked and their handles parallel, the closed blades of each side are brought opposite to each other so as to form one complete ellipse (Fig. 946). If now both forceps be opened simultaneously to an equal extent, the primary ellipse is divided into two by the separation of the blades.

The manipulation of the instrument consists, first, in opening it so as to cause an even separation of the rings and in inserting one of the rings within each lumen of the segments to be joined, thereby bringing the blades in direct contact with mucous surfaces internally, while the serous coverings remain external and overlie the compressing surfaces of the rings. The latter are then compressed together, whereby the included serous surfaces are brought in contact and the coats held firmly in apposi-

tion while the sutures are inserted. Serous surfaces are brought into
contact throughout the entire circle of compression, with the exception
of the site of exit of the handles of the instrument from the seat of opera-
tion where mucous membrane lines the opening. This latter is of advan-
tage rather than otherwise, for on withdrawal of the instrument—which
is done by unclasping the locks and removing each lateral half separately
—the blades of each half in their exit sweep over mucous membrane only
and come in contact with no serous surface. There are five different sizes
of instrument to suit the various operations of anastomosis, including one
for cholecystenterostomy, and another very small instrument used for the

FIG. 945.—The Laplace
forceps unlocked.
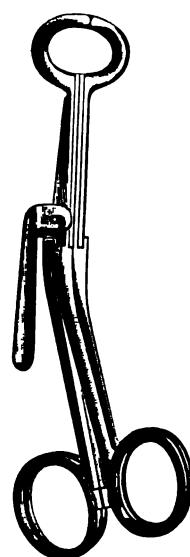
FIG. 946.—The Laplace
forceps locked.

anastomosis of the ureter with the intestine, which is done by the lateral
method.

End-to-End Approximation.—In end-to-end approximation the ends of
the intestine are first tacked together with four equidistant traction sutures
passing through all the coats. One, placed at the site of junction of the
mesenteric borders, is inserted with special care to include both layers of
each mesentery, so as to close the triangular space of each segment which
exists between the layers of the peritonæum at this situation; another is
inserted at a point of the intestine opposite to this one; of the remaining
two one is inserted at either side, midway between the first and second
sutures (Fig. 947). The approximation forceps is now introduced, with
blades closed, into one of the spaces between the sutures, excepting, how-
ever, those spaces next to the suture joining the mesenteric borders. The
blades are then opened, and the rings, as they separate, are made to pass
one into either intestinal extremity. If the edges of the gut tend to evert

instead of falling between the rings, they can readily be drawn into place by a single turn of a thread passed around the line of the sutures between the blades. The instrument is then clamped, and in so doing the entire
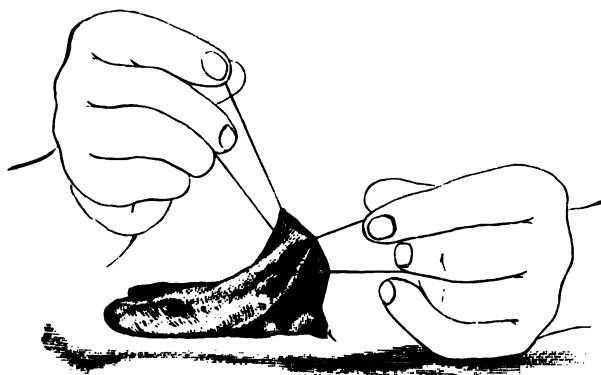
FIG. 947.—End-to-end approximation, traction sutures in place.

serous surfaces around the openings are accurately brought together for sewing, excepting where the blades have exit (Figs. 948 and 949). The thread is withdrawn just before the blades are clamped. The further technique is the same as in end-to-end approximative anastomosis.

The Comments.—If before clamping it be found that the slits have been made a little too long to be included within the grasp of the blades, they can be shortened by a little lateral traction on the openings, making them a diamond shape, and thus approximating their extremities. The external portion of the adjusted instrument now acts as a handle to hold the

FIG. 948.—End-to-end approximation, forceps in place.

seat of operation in proper position, which is of particular value in such operations as cholecystenterostomy and von Hacker's operation for gastro-enterostomy, where the surfaces to be sewed are difficult of approximation.

When the sutures have been placed for one half the circumference of the rings, by a half turn of the instrument—and, if a continuous suture be used, at the same time passing the needle behind the seat of operation—the remaining half of the circle is brought conveniently into place for the completion of the sewing.

In the withdrawal of the blades from within the intestine, each forceps, after unlocking, must be first pulled directly outward until the elbow at the junction of the straight with the curved portions of the blades is well clear of the intestine before the handles are swung around to finally extricate the semi-ellipse. The operation is completed by the inversion of the pouting mucous membrane at the opening which remains, and the closure of the latter with sutures.

Lateral Approximation.—In lateral approximation openings are made in the two hollow viscera to be joined, each a little longer than the trans-

FIG. 949.—End-to-end approximation, sutures placed.

verse diameter of the elliptical rings of the instrument, so as to just admit of the easy entrance of the rings through the openings. The anastomosis forceps is opened and one metal ellipse is inserted into one of the openings and the other ellipse into the other opening, both passing entirely within the interiors of the respective viscera. Slight traction is then made on the handles of the instrument to draw the straight portions of the blades, which are just above the rings, snugly into corresponding extremities of the openings, which traction makes the latter assume a position in line with the short diameters of the ellipses and become parallel.

The Invagination Forceps.—This instrument is a long and narrow straight forceps, devised by Laplace (Fig. 950), by means of which the free end of a divided intestine is grasped close to its divided margin and the included tissues invaginated deeply within the gut, after which the serous borders are sewed over the invaginated portion, closing the end of the intestine preparatory to lateral anastomosis. The instrument is left *in*

situ as long as possible during the sewing, and when finally withdrawn the site of its exit is likewise closed by suturing.

FIG. 950.—The Laplace invagination forceps.

Dr. Laplace states the advantages of the anastomosis forceps as follows:

" First, rapidity and accuracy of suturing without leaving any foreign substance within the gut; second, an absolute control of the field of operation by means of the assistance of the handles of the forceps; third, the facility with which the forceps is applied, preventing the escape of intestinal contents during the operation."

The Comments.—In two anastomoses performed on dogs by Dr. Laplace there occurred a subsequent closure of the opening of communication between the viscera joined. It happened where a thin intestinal coil was joined to a thicker one, and the failure to establish a permanent communication was ascribed to the fact that the sutures were not made to pass deeply enough through the coats of the thicker segment to shut off the circulation from the tissues immediately around the opening in the same, so that, instead of a sloughing of the margin of the aperture, granulations sprang up from the raw edges and effected the closure of the opening.

While this apparatus is ingenious and permits of rapid execution, it is apparently open to the objection so common in other methods—subsequent contraction of the intestine due to the invaginated ends.
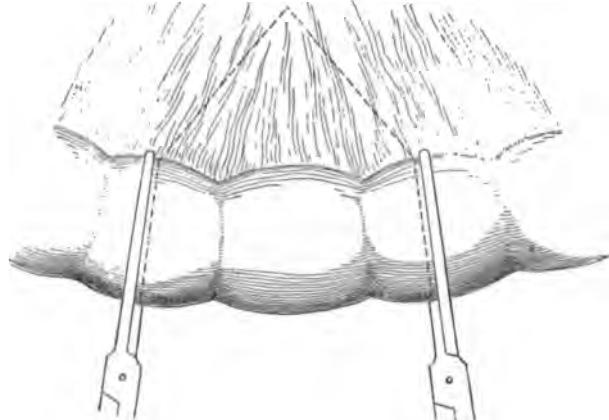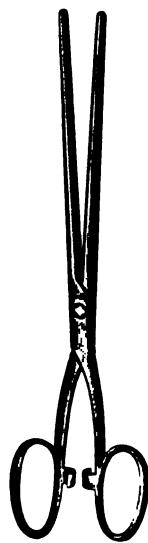
FIG. 951.—O'Hara's forceps. Showing the manner of placing forceps in resection of bowel; dotted ines show the incision to be made.

O'Hara's * *Approximation Forceps.*—These forceps are praiseworthy because of the simplicity of their construction and of their practical appli-

* Annals of Surgery, February, 1901.

cation, if for no other reasons (Fig. 1008). The fact that the viscus remains closed until the last moment is an important feature for apparent reasons. However, were they to slip their grasp in the presence of an
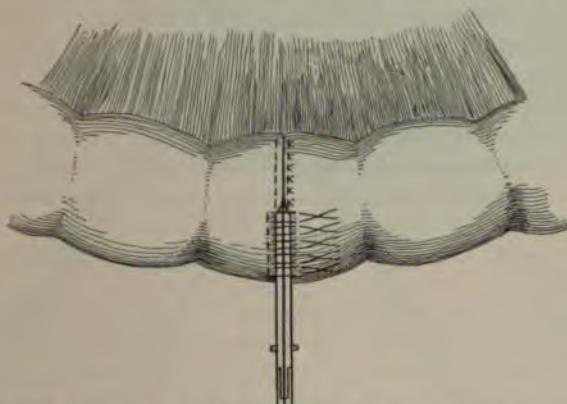
FIG. 952.—O'Hara's forceps. End-to-end anastomosis. Forceps brought together and held by serre-fine (not shown); sutures introduced, some of which are tied.

unrestrained fecal escape, the procedure would be at once greatly complicated. Therefore, we are prompted to advise that some one of the accepted forms of hindrance of escape be applied at both extremities of an emptied area, before resection is made.

The Operation.—Apply the forceps directly across the bowel as indicated (Fig. 951), observing that their distal ends are in an exact line with

FIG. 953.—Lateral anastomosis: O'Hara's forceps applied in a line with the long axis of the gut.

the mesenteric attachment; remove the intervening part of intestine with scissors, cutting quite close to the forceps; bring accurately together the

forceps, and hold them there firmly with the serre-fine clamp applied to the shank of the forceps; introduce the sutures from the free border of the bowel to the attached border, carefully suturing the mesenteric portion (Fig. 952), turn the forceps over, exposing the posterior surface of the bowel, and suture outward to the stem of the instrument; unclamp the forceps, unlock and remove one pair; unlock the second pair and move the end upward and downward in the intestine before withdrawal, noting if any sutures have invaded both walls of the gut; close the opening of exit of the forceps, with one or more sutures, re-enforcing with sutures, if need be.

In Lateral Anastomosis.—With this instrument a portion of each viscus is picked up with thumb forceps and grasped by the instrument (Fig. 953), the projecting portions cut off with scissors, the forceps finally approximated, as in the preceding instance, when the sutures are introduced as before.

The Remarks.—The piece of mesentery is treated by removal or by overlapping, as suits the purpose of the operation; if interrupted sutures are employed, they need not be tied until after all are introduced into that side or possibly one person may tie while another properly introduces them. Avoid traction on the gut in turning over the forceps.

Bobbins.—Bobbins are made of various kinds of material, and are usually known as the "Digestible" and the "Crushable" bobbins. The former class is mainly represented by the different kinds of decalcified *bone bob-*

bins. Bone bobbins as agents of intestinal approximation are connected in idea with the devices of Senn and Murphy. *Landerer* commends potato bobbins. These latter, and those made of sugar, gelatin, bread, turnip, potato, etc., are often serviceable.

Coffey, after long and patient labor on "The respective merits of the various methods of intestinal anastomosis," * presents the following as the result of his efforts:

Coffey's Crushable Bobbin.—This bobbin is made preferably of potato. It should be of sufficient length to support the intestine and of suitable size to readily enter it (Fig. 954).

The Operation.—Close the base of the mesenteric triangle as indicated in the methods of Maunsell and Connell (Figs. 926 and 937), introduce into the intestine and transfix with two pins the borders of the intestine and the (thin) potato bobbin (Fig. 956), unite

Fig. 954.—Coffey's "Crushable" potato bobbin.

the intestinal borders by means of mattress sutures (Fig. 957), or the continuous suture, at all points except those occupied by the pins; finally remove the pins and suture these points; push aside the bobbin and crush it, leaving it to care for itself.

The Remarks.—Any one of the crushable agents besides potatoes can be used, but potatoes and bread are the easiest attainable materials under

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* Jour. Amer. Med. Asso., November 1, 1902.

all circumstances. The mattress suture seems best suited for the purposes
of this form of practice.

The Decalcified Bone Bobbin of Robson (Fig. 958).—The manner of
its application is easily comprehended and can be readily practiced. Two
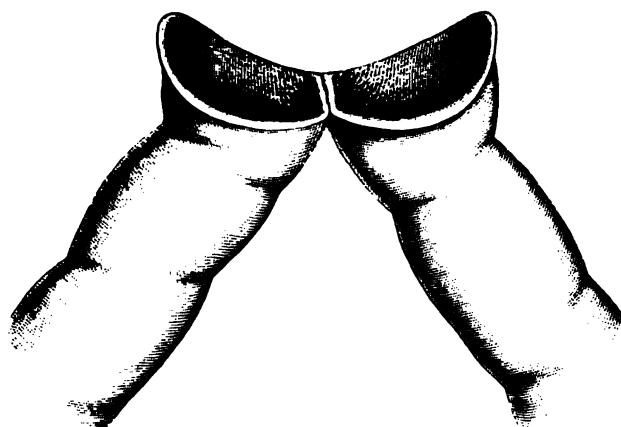
FIG. 955.—Coffey's method. Mesenteric attachment closed; bowel ready for insertion
of bobbin.

rows of continuous sutures—an internal muco-mucous (*a*) and an external
sero-serous (*b*)—are employed. Begin by introducing the internal sutures
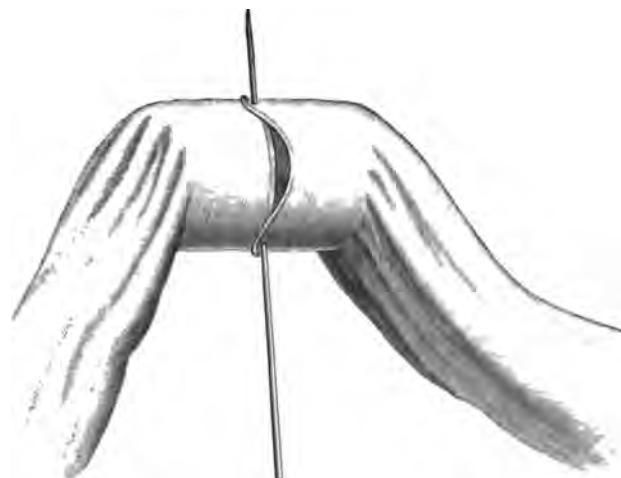
FIG. 956.—Coffey's method. Transfixion passed through borders of intestine and
the potato bobbin.

at the farther half of the intestine, followed at once by the external for
the same distance. Put the bobbin in place and complete the internal
muco-mucous suture, followed by completion of the external sero-serous

suture.   The continuous is employed for the internal suture.   Either the
Lembert or the Cushing variety may be applied externally.   When great
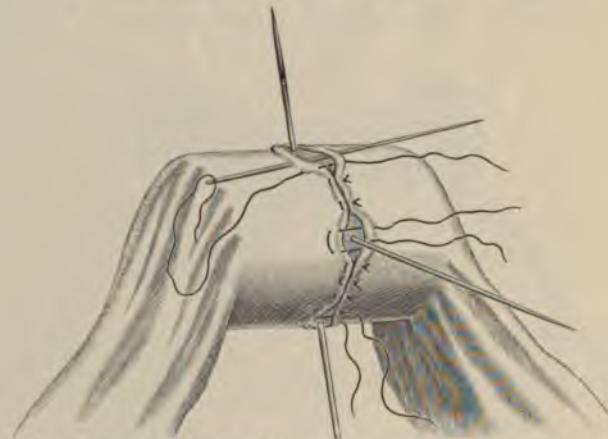
Fig. 957.—Coffey's method.   Mattress sutures inserted; some are tied.

haste is essential a single row introduced deep enough to pierce the sub-
mucous fibrous coat will suffice.
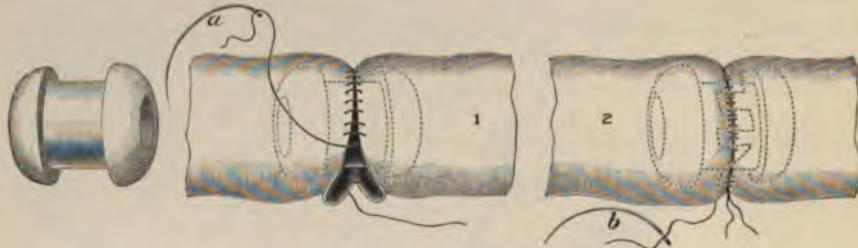
Fig. 958.—The bone bobbin of Robson.   *a.* The continuous muco-mucous suture.
b. The continuous sero-serous suture.

The Bone Bobbin of Allingham (Fig. 959).—The center of this bobbin
(*a*), and for a quarter of an inch at either side of it, is not decalcified, and
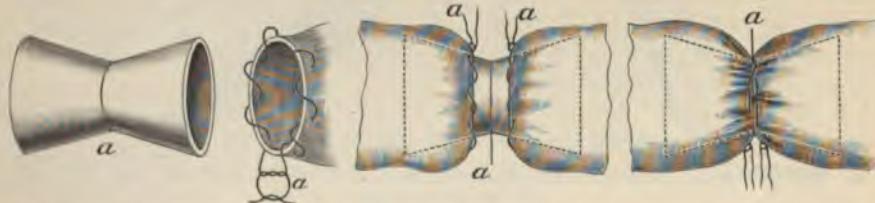
Fig. 959.—The bone bobbin of Allingham.   *a.* Bone bobbin disconnected and in place.

therefore is not influenced by suture pressure.   The remaining portions are
decalcified.   The shape of this bobbin tends to approximate the divided

borders when closed around it, also opposes their slipping away. To apply it, carry a purse-string suture around each end of the intestine (*a, a*) ; insert one end of the bobbin into the extremity of a segment of intestine; draw the suture tightly around the bobbin, tying with a single knot at first; introduce the remaining end of the bobbin into the extremity of the remaining segment and tie as before; push the ends firmly together at the center of the bobbin and tie an additional knot in each; supplement the line of union with continuous or interrupted sutures if needed (*a*). This method of practice seems insecure without the supplementary stitches. Little can be said as yet of the outcome of its practical application.

Harrington's Segmented Ring.—This bobbin-like agent is made of hard aluminum in four sections, each so tongued or grooved as to remain in contact when joined together and held by the steel handle (Fig. 960). The outer surface is grooved to hold in place the purse-string sutures introduced at the ends of the intestines. The rings are of assorted sizes and suited for use in the large and small viscera. The heaviest one weighs two drams, being less than that of the lightest Murphy button.

The Technique.—Apply a purse-string suture an eighth of an inch from the outer limits of the proposed resection without invading the lumen of the intestine ; tie lightly the first fold of the knot (Fig. 961, *a*), cut away the intestine at either limit and intro-

Fig. 960.—Harrington's segmented rings, assorted sizes, separated segments and segments joined and held in place by steel needle.

duce at the mesenteric border a mattress stitch, leaving it untied (Fig. 962, *b*) ; introduce the ring, tie the purse-string sutures, also the mattress stitch at the mesenteric border; adjust suitably for sewing the ends of the intestine; begin the sewing at one side of the steel handle, employing Cush-

a   *b*
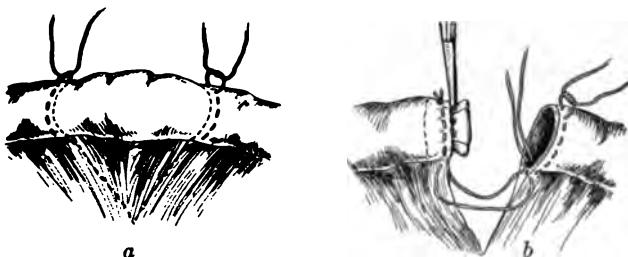
FIG. 961.—Harrington's segmented ring. *a.* Purse-string sutures applied, lightly tied and line of resection marked out. *b.* resection made, mesenteric mattress stitch applied, ring introduced at one end and purse-string suture tied.

ing's continuous suture, with frequent knots, until the handle is reached at the opposite side (Fig. 962, *a*) ; unscrew the handle, leaving the ring sup-

* Annals of Surgery, November, 1904.

ported by the purse-string sutures; close the opening in the intestine left by
the removal of the handle and unite the edges of the mesentery with inter-
rupted sutures (Fig. 962, *b*).

Lateral intestinal and gastro-intestinal anastomosis by this agent is
quite easily accomplished. Place the sutures as indicated in Figs. 963 and
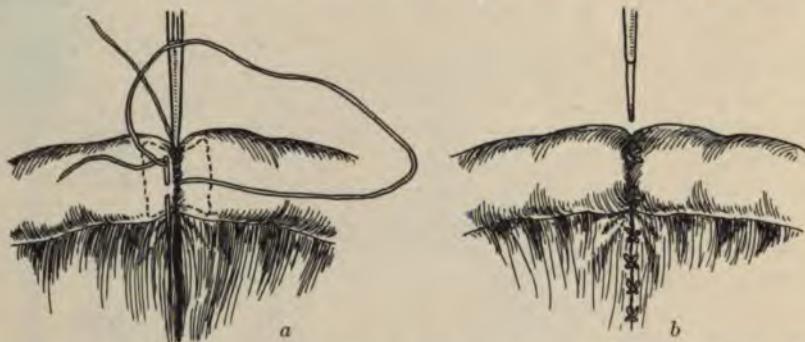
FIG. 962.—Harrington's segmented ring.   *a*. Sewing begun, intestine held by handle of
ring.   *b*. Sewing completed, handle unscrewed and removed.

944, divide the tissue between them and introduce and hold in place the
ring as before, treating first the stomach; unite the serous surfaces of the
respective viscera with the simple or Cushing continuous suture.

The Remarks.—Leave the ring in place unless "it causes decided
stretching of the intestines," when it "should be broken before closing the
abdomen." The ring usually collapses after four to six days, escaping in
segments within one to three weeks. The following objections are frankly
stated by the designer: 1. The general objections to mechanical contrivances.
2. The general objections to one layer
of sutures. 3. A too large ring may
cause sloughing of the suture from
pressure. 4. A foreign body in the
intestine is always a source of danger.

FIG. 963.—Harrington's segmented ring.
Gastro-intestinal anastomosis, ring in
stomach, suture of intestine laid and
loosely tied.

The Results.—Nine cases have
been treated by this method. Five
gastro-enterostomes; 2 recovered and
3 died. Two died from the effects of
the disease, one from obstruction due
to a "kink" at the seat of the button.
One cholecystenterostomy; recovered.
One intussusception; died in a few
hours. One lateral intestinal anasto-
mosis for cancerous obstruction; re-
covered. One end-to-end anastomo-
sis; recovery.

End-to-end approximation of unequal segments of intestine can be easily
accomplished by Maunsell's method (Figs. 926 *et seq.*), by the Murphy but-
ton without any reduction in the diameter of the larger segment, and by the

removal of a longitudinally placed V-shaped portion from the larger end. In addition to these methods, *Wehr* advised that the end of the narrower bowel be divided obliquely at the expense of the convex border in such a manner as to cause the open extremity to conform in size with that of the larger intestinal segment (elbowing) (Fig. 1003). In this instance two rows of sutures are employed, the same as in end-to-end sewing in other methods.

However, the danger of sloughing of the line of sewing is increased by two rows of sutures, especially if the final be tightly drawn.

Fig. 964.—Senn's method of performing lateral anastomosis. *a.* Plates in position within the intestine. *b.* After completion of the operation.

Lateral Anastomosis.—Lateral anastomosis is employed to establish a continuous communication between the intestine above and the intestine below a more or less permanent obstruction (Fig. 964). It is practiced instead of resection when the difficulty can not for a good reason be merely removed.

The Method of Lateral Anastomosis of Senn.—Senn's practice and advocacy of lateral intestinal anastomosis through the agency of decalcified bone plates (now rarely used) brought both the method and utility of the operation into prominence. The margins of the opening are provided with four silk sutures in the following manner: Thread each of two fine sewing needles with a fine aseptic silk thread twenty-four inches in length; tie the ends of the threads together and bring the needles to the middle (Fig. 966); draw a loop (Fig. 967) of the thread through each of the perforations and confine the loops in place by means of a thread passed through them and firmly tied (Fig. 968).

Fig. 965.—The decalcified bone plate of Senn. *a, a.* Fixation sutures. *b, b.* Approximation sutures. *c, c, c, c.* Opening in plate and anchor thread.

Fig. 966.—Silk threads tied, needles at the middle.

Stamm introduced the sutures into the plates in such manner as to cor-
respond with each other when tied, thus properly fixing them in position
(Fig. 969). The plates are properly kept for use between two pieces of glass
immersed in a solution made of equal
parts of alcohol, glycerine, and water.

The plates are applied in the fol-
lowing manner: The loops of intestine
to be joined are drawn out through
the abdominal wound and carefully

FIG. 967.—Threading Senn's plate.
Passing first loop.
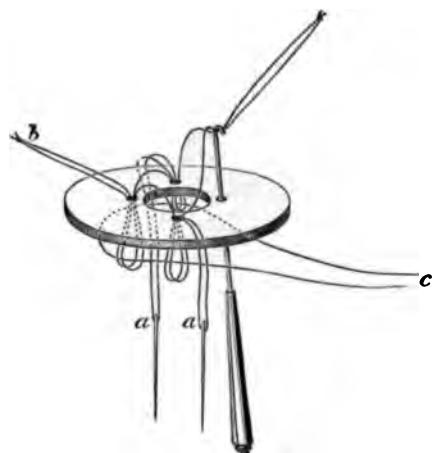
FIG. 968.—Threading Senn's plate. Passing
last loop, anchor thread (*c*) passing through
three loops.
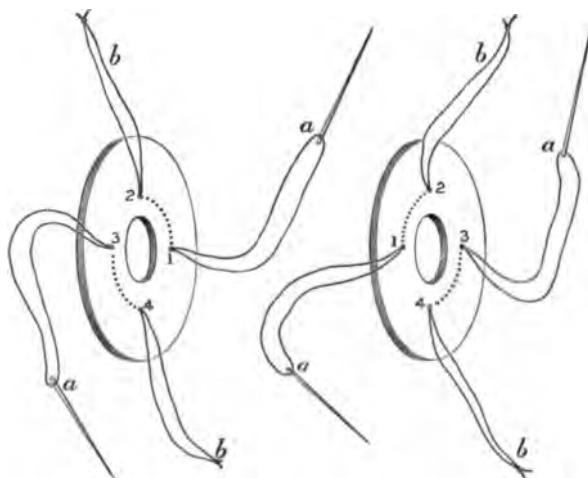
FIG. 969.—Stamm's arrangement of sutures.
a, a, a, a. Fixation sutures. *b, b, b, b.* Approximation sutures.

isolated with gauze, the contents of the bowel pushed aside and return is
prevented by some form of intestinal clamp. An opening is then made in

the long axis of one of the portions of bowel opposite the mesenteric border nearly equal in length to the long diameter of the perforation in the plate (Fig. 944). The plate is inserted into the bowel endwise, and the borders of the wound are properly adjusted to its surface by traction on the sutures, aided by manipulation with the fingers, after which the fixation sutures (aa') are carried through the borders of the wound halfway between the
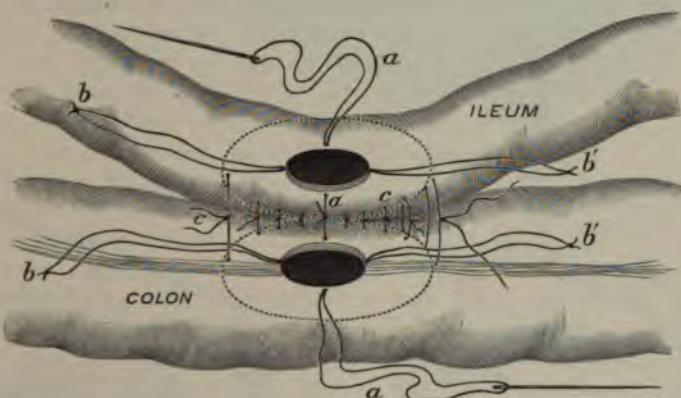
FIG. 970.—Lateral anastomosis, Senn's method.   Plates introduced.

angles by means of the needles. The remaining loop of intestine is treated in a similar manner. Several sero-muscular sutures are then inserted behind the plates (c), and the internal (a') fixation sutures are tied (Fig. 970). The intestinal wounds are now brought into apposition and confined there by tying and cutting short the external fixation sutures (aa), then the apposition sutures (bb, b'b') at either end. The operation is completed
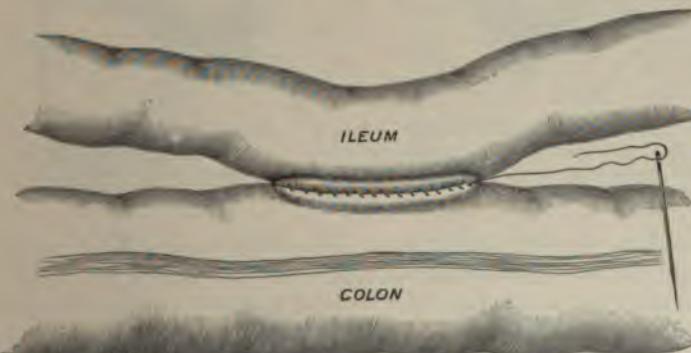
FIG. 971.—Lateral anastomosis, Senn's method.   Plates approximated, sutures tied, continuous suture introduced.

by carrying a continuous suture through the serous surfaces at the outer borders of the approximation plates, thus fortifying the union and increasing the area of contact (Figs. 971, 972, and 973).

... adjusted. Dawbarn regards this
... greatly simplifies and hastens the pro-
... covered with a cloth wet with antiseptic fluid,
... scalpel to hasten union, and the
... beginning with the undermost one, as in
... whether the open ends of the intestine
... portions before the plate sutures are tied.
... used without, opposite to each plate suture,
... numerous sutures of this pattern, or a con-
... around the borders of the plate for a sim-
... strip of wood is now introduced into the open
... beneath the potato plate, and through the
... apposed intestinal walls are divided with a
... scissors in a line corresponding to the slit in

... Lateral anastomosis, Dawbarn's method. Parts approximated; strip of wood and the knife introduced to form the anastomotic opening.

... down upon the apposing surface of wood (Fig. 976). Arrest ... hæmorrhage by means of forceps passed through the open ends of the ... irrigate the wound, thus cleansing it and testing the integrity of ...

The open ends of the intestine are invaginated and closed by continuous or interrupted sutures. Dawbarn now advises the use of curved sweet-potato plates, armed with a ligature at either end, instead of those just described (Fig. 977). Securer approximation when tied in place, longer duration as restraining agents, and greater dispatch of application are the chief claims of advantage for this variety. It should not be overlooked, however, that demands may happen where sweet potatoes are not available for use.

Remarks. The novelty of the proposition of the use of vegetable plates and the successful demonstration of their utility, together with the

possible need for their employment, gives to them an important and definite position in the field of surgical endeavor. Four instances of use in the human subject of the potato plates, with three recoveries are reported.

Lateral Anastomosis with Segmented Rubber Plates (Robinson). — According to the designer, " take two pieces of rubber band, similar to those used in closing a purse or a bundle of papers, about two and a half inches long and three and a quarter inches wide. For larger openings the bands should be longer. Cut the corners off, as shown in Figs. 978 and 979. In

Fig. 977.—Lateral anastomosis, Dawbarn' amended method. Curved sweet potato plates in place.

the center and at the side of each band to be approximated cut out a triangular piece, leaving, when the two halves are fastened together (*c, c*), a square aperture in the middle of the plate. Cut out two holes (*gg, gg*) at
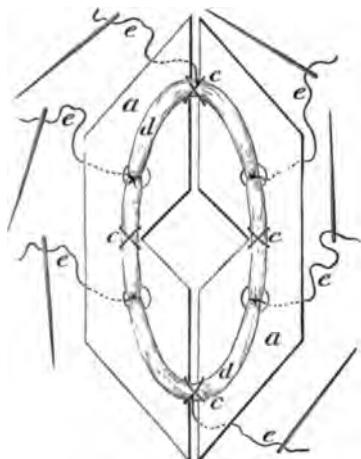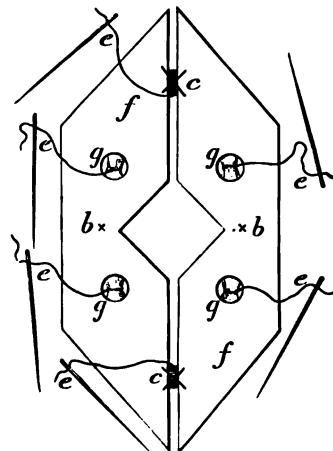
Fig 978.

Fig. 979.

Fig. 978.—Lateral anastomosis, segmented rubber plates, Robinson's method. *f, f.* Face of plate. *c, c.* Stitches joining rubber segments at ends. *g, g, g, g.* Lateral holes in plates for sutures. *e, e, e, e, e, e.* Sutures tied to chamois ring, passing through holes armed with needles. *b, b.* Sides of segment stitched to chamois ring.

Fig. 979.—Lateral anastomosis, segmented rubber plates, Robinson's method. *a, a.* Back of plate. *d, d.* Chamois ring stitched to plate at *c, c, c, c. e, e, e, e, e, e.* Six sutures armed with needles, each fastened to chamois ring, one passing between the segments at either end of the plate.

each side, half an inch apart. The holes are made large, so that the part of the chamois-skin ring, to be described, with the linen thread, will easily

55

pass through. From a piece of chamois or sheepskin cut off several long strips, like wide shoestrings, and twist two or three of them together so as to form a ring. This ring (d) is fastened to the plate, as shown in Fig. 979, with catgut sutures (c). Finally, loop six linen sutures (e) (Bar-
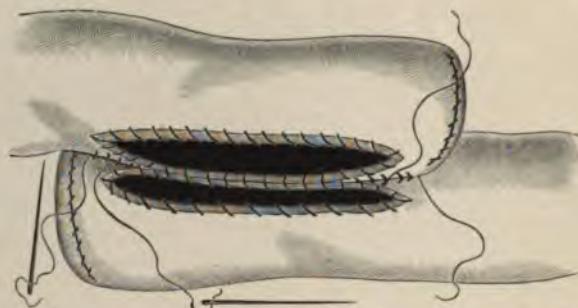
FIG. 980.—Lateral anastomosis, Abbe's method. Lower rows and whipstitch rows of sutures introduced.

bour, No. 40), armed with milliners' needles, on the ring and the plate is ready for use."

The openings into the viscera for the purpose of introduction of the plates should be three and a half to four inches in length. A plate is carried through the opening into the organ and the needles are caused to traverse its walls at a proper distance from the edge of the incision, from within outward.

The threads of the plates should correspond with each other when the latter are in proper position, so that when tied the plates and tissues will be properly adjusted. The sutures are cut short, and the union is reinforced by Lembert sutures placed at the borders.

Lateral Anastomosis by Sewing Only.—Abbe advocates strongly the abolition of all mechanical devices in intestinal anastomosis. He regards
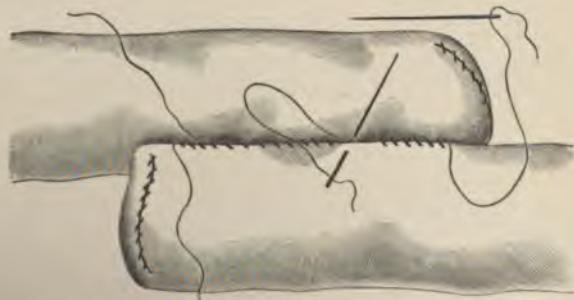
FIG. 981.—Lateral anastomosis, Abbe's method. Anterior rows of sutures applied.

union by sewing as being the only safe and reliable measure. After excision of the intestine has been performed, invert the open ends of the divided bowel, and close them with a double row of colored silk sutures; overlap the

closed extremities of the bowel four inches or more, or reverse and place them end to end as is most convenient; unite the apposed surfaces by two parallel rows of continuous sutures, each four inches in length, placed a
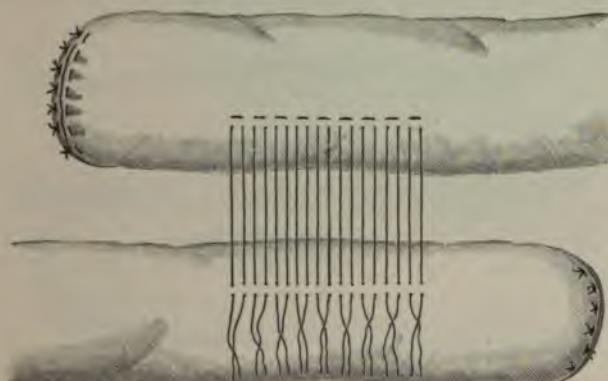
Fig. 982.—Lateral anastomosis, Halsted's method. Posterior mattress sutures introduced.
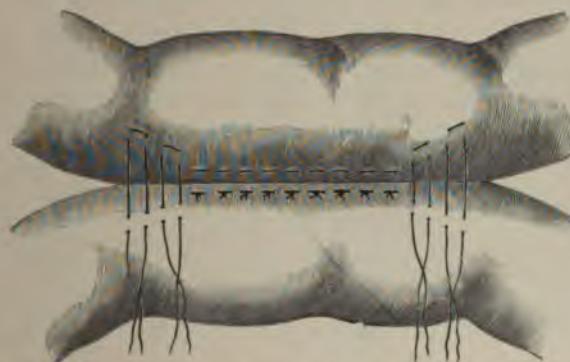
Fig. 983.—Lateral anastomosis, Halsted's method. Posterior sutures tied, incurvation sutures applied.

Fig. 984.—Lateral anastomosis, Halsted's method. All sutures tied, forward curving established.

quarter of an inch apart, and introduced by means of cambric needles, each armed with a colored silk suture twenty-four inches in length, each suture

being left at the end of its row still threaded (Fig. 980); make a longi-
tudinal opening into the side of each extremity of intestine, about an eighth
of an inch from the line of sewing, four inches in length; sew rapidly with
overhand stitch the borders of either opening with a third needle armed
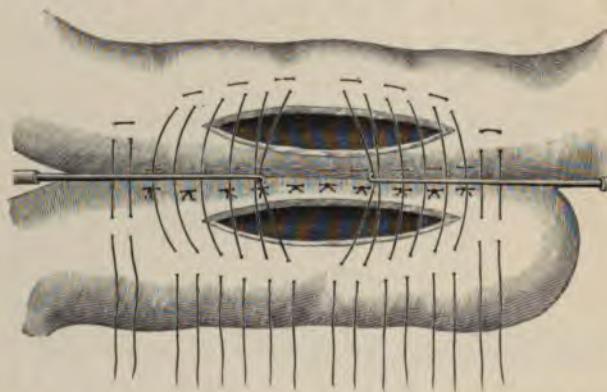
FIG. 985.—Lateral anastomosis, Halsted's method.   Incisions made and sutures laid for
closing.

with a long colored silk suture, which unites together those margins already
apposed; cleanse the parts and complete the union by the continuance of
the first two rows of sutures around the opposite unsecured edges, thereby
providing three rows of sutures for the lower and two for the upper line of
union (Fig. 981).

The Remarks.—The primary rows of sutures should be made about an
inch longer than the proposed opening into the intestine. The whipstitch,
passed around the borders of the respective openings, secures the proper rela-
tions of the coat of the intestine at these places, and also arrests the bleed-
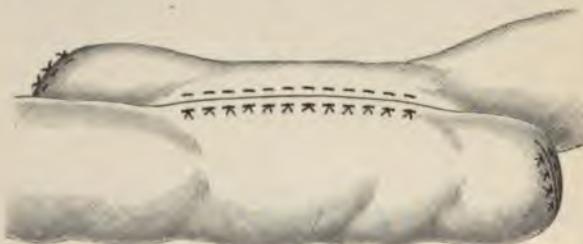
FIG. 986.—Lateral anastomosis, Halsted's method.   Anterior row of sutures tied;
operation completed.

ing. Only nimble fingers, directed by much experience, can quickly and
satisfactorily accomplish this form of union.

Halsted's Method.—Halsted's method of sewing differs from that of the
preceding. He employs the mattress suture, and introduces but one row.

The portions to be anastomosed are placed side by side, and joined to
each other by six or eight mattress sutures introduced opposite the attach-

ments of the mesentery (Figs. 982 and 983) and tied. Two additional sutures are so introduced at either end of the preceding (Fig. 983) as to cause forward curving of the line of approximation when tied (Fig. 984). The anterior row of sutures—ten or twelve in number—is now laid, but before tying are drawn apart (Fig. 985), and an opening of proper size is made at either side of the primary sewing into the intestine. The sutures are then tied (Fig. 986) and the operation is completed.

The Remarks.—This method is simpler, easier, and more quickly practiced than is the preceding. The sutures necessary for the purpose should be prepared in advance and the needles threaded before operation begins. The use of interrupted sutures instead of continuous is still another commendable measure. The submucous fibrous coat is included by the sutures.

Maunsell proposed the invagination of the open ends of the intestinal segments by means of sutures (Fig. 987) carried out through the anas-
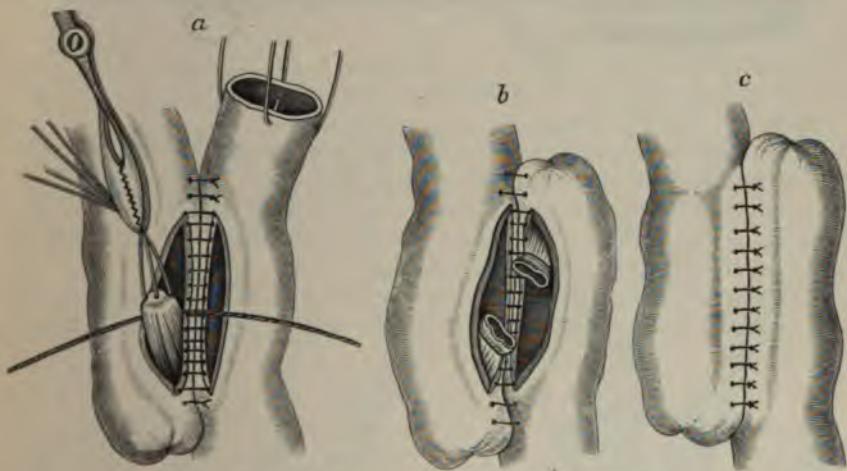
Fig. 987.—Lateral anastomosis, Maunsell's method.

tomotic opening (*a*). The extremities of the invaginated portions are tied, dropped into the lumen (*b*), the opening closed, and the ends connected by a stitch or two with the contiguous bowel (*c*).

The Comments.—It is questionable if this be as good or a quicker way than sewing the open ends. The final fixation sutures are quite equal in all respects to those employed in the common method of closure.

Lateral Anastomosis by Enterotome (Grant).—A blade of the opened instrument (Fig. 988) is inserted into each segment of intestine and the blades are closed, thus dividing the approximated wall and closely apposing the peritoneal surfaces for sewing, which is quickly accomplished (Fig. 989). Remove the instrument, invaginate the open ends, and close them by sewing.

The Remarks.—The instrument controls the tissues admirably while the sewing is being done, and also the bleeding. It facilitates the procedure and is, withal, a commendable device. *Wyeth* suggests, very properly, that the incision should be made not less than four inches in length.

The pouching of the intestine in this instance constitutes not only a useless deformity, but also may become highly objectionable as the seat of fecal detention.

Lundholm's Method.—Lundholm presents this, a comparatively recent device for intestinal anastomosis, etc., which has the merit of being simple, expeditious, and serviceable.

The Description of Instrument (Fig. 990).—(*a*) Longitudinal grooves on inner surfaces of the blades, forming a rectangular tunnel closed at one

FIG. 988.—Grant's enterotome.

end when forceps are locked; (*b*) the transverse grooves extending around outer surfaces of both blades; (*c*) sharp-pointed stylet to introduce into the tunnel formed by the grooves to cut the intervening visceral walls; (*d*) a blunt stylet for introduction, while hot, into the groove to cauterize the already divided borders, obviating bleeding.

The Introduction and Adjustment of Instrument; Beginning Sewing (Fig. 991, *a, b, c*).—One blade of the forceps is piercing the gastric or
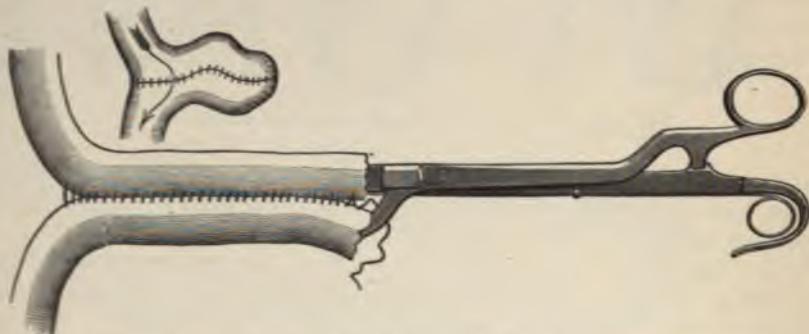
FIG. 989.—Grant's instrument, operation for lateral anastomosis.

intestinal wall, being securely held in position by tying the puckering ligature already placed for the purpose around the openings into one of the grooves of the blade (*a*), which device also prevents the leakage of stomach or intestinal contents. The other blade (Fig. 991, *b*) is being carried into the intestine through an opening also guarded by a puckering ligature. The opening is held by an assistant so as to readily admit the end of the blade without danger of injury to the wall of the gut.

Fig. 991, *c*, the forceps are introduced and locked, the viscera approximated, and the upper side of the instrument exposed to view. A white continuous silk suture going through all the coats of the viscera, drawing
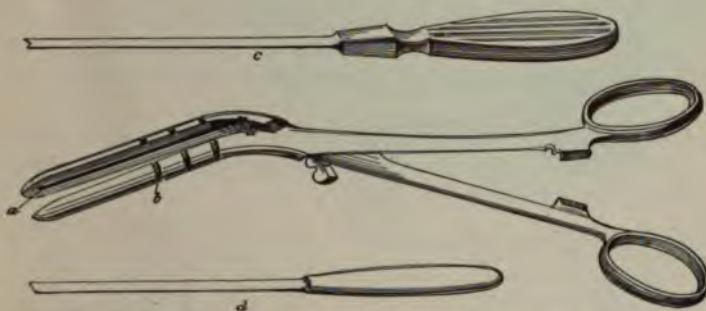
FIG. 990.—Lundholm's forceps, for intestinal anastomosis.

them over the blade, is being covered in by a black catgut suture not going so deep. The ends of both sutures are left long for tying within the corresponding ends when the sewing is completed at the point of beginning.

The Completion of Sewing and Removal of Instrument (Fig. 992, *d*). —The under surface of the instrument is turned up to permit the sewing
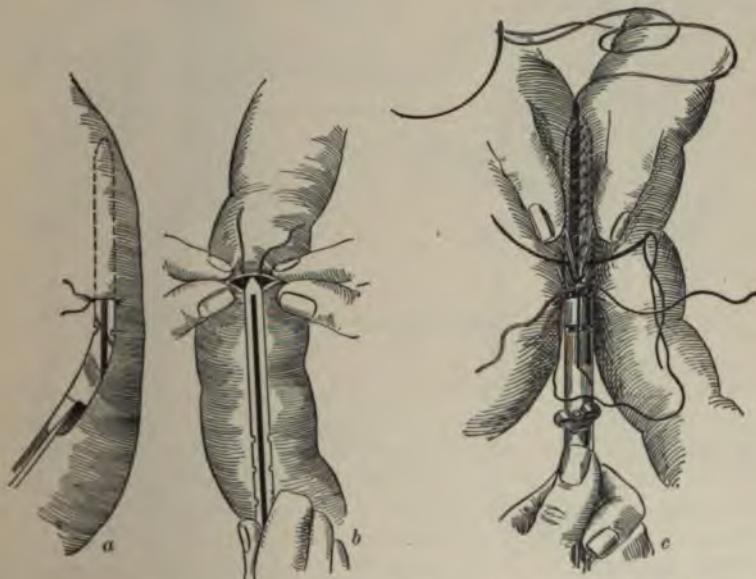
FIG. 991.—Lundholm's method of intestinal anastomosis.

with silk to be completed up to ✕, where the suture is tied, followed by the carrying of three loose stitches around the instrument, ending at the starting point. The black catgut suture is completed to the point, there tied

and left long. At this time the stylet is pushed along the grooves, severing
the intervening walls of the viscera and the purse-string ligatures. The
heated cauterizing stylet should follow immediately after, if hæmorrhage
be feared.

Fig. 992, *e.*—The instruments and the severed puckering ligatures are
taken away, and it remains to turn in the borders of the opening and close
it by the circular stitches already placed, when the two ends of the silk
sutures are tied together.

The Remarks.—In this method the restraining agent should be applied
at the outer limits of the emptied segment, when possible, for greater
security against infection.
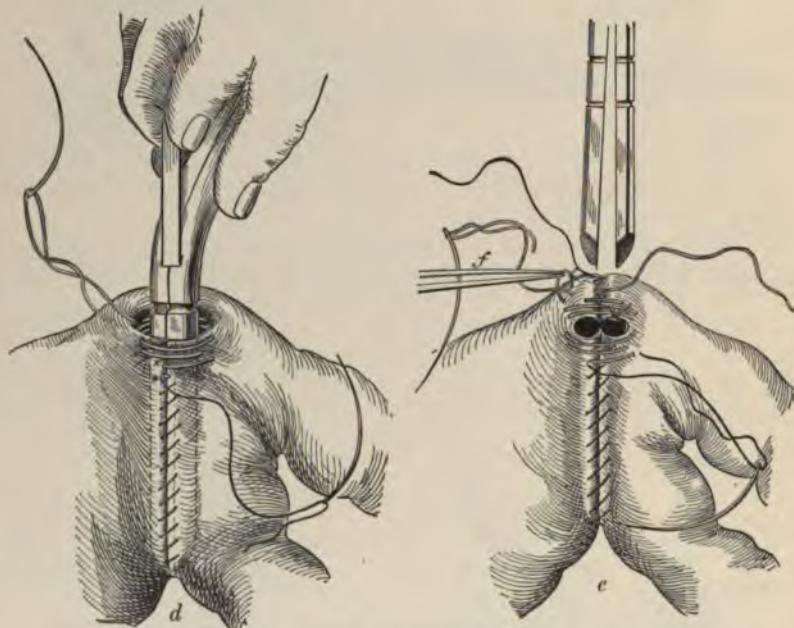
FIG. 992.—Lundholm's method of intestinal anastomosis.

The length of the opening can be regulated by the distance of the intro-
duction of the blades. Vessels of threatening size should be avoided.
Hæmorrhage can be prevented by the sewing, the pressure of the blades,
and by the cauterizing effect of the stylet. Lundholm reports, of his own,
five gastro-enterostomies and a lateral anastomosis of the intestine, with an
entero-anastomosis in each of four stomach cases, with no death.

Lateral Implantation is the result of imitating the anatomical arrange-
ment of the junction of the ileum and colon. The end of the ileum is
treated as described in Senn's method of end-to-end joining by aid of the
rubber band (Fig. 925). A longitudinal slit is then made in the colon and
a quilt stitch is introduced primarily at the borders of the slit (Fig. 993)
or by the way of the open end of the bowel through either border of the

slit, thence through either side of the small proximal end of the gut; by these means the proximal end is drawn into the large intestine in such a manner as to cause inversion of the borders of the opening in the colon, thus bringing in contact with each other the serous surfaces of the respective intestines, which are then joined by a continuous suture applied at the border of external contact (Fig. 994).

Maunsell's Method.—If the end of the colon be open, one can proceed as follows: Pass long silk ligatures (four in all) through the ileum from within outward, then through into the colon, near to the edges of each of these intestinal openings (Fig. 995, *a, b, c, d*);

FIG. 993.—Lateral implantation by direct sewing, or through the open end of the colon.

FIG. 994.—Lateral implantation, union completed.

tie them firmly, and pass the ends through the slit in the colon and out through its open end (Fig. 996, *a, b, d*); seize them with forceps and by gentle traction invaginate the apposed borders, causing them to appear below at the open end of the gut (Fig. 997); sew the borders as in Fig. 929; disinvaginate carefully, close the end of the colon, and fortify the line of junction externally with several sutures that include the sero-muscular coats of the intestinal walls (Fig. 998).

FIG. 995.

FIG. 996.

FIG. 995.—Lateral implantation, Maunsell's method.   *a, b, c, d.* Sutures in position.
FIG. 996.—Lateral implantation, Maunsell's method.   *a, b, d.* Sutures carried through open end of colon.   *c.* Suture remaining behind.
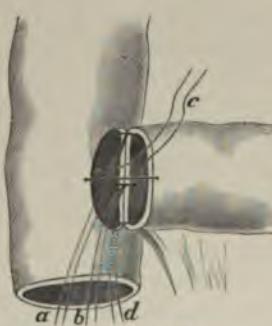
A choice of the preceding measures will depend very much indeed on the skill and experience of the operator, and the condition and environ-

ments of the patient. If the condition of the patient demands rapidity of
action, either the Murphy button, the bone bobbin, the " crushable " bobbin
and Maunsell's method can be employed, depending, of course, on the prepa-
ration and practical wisdom of the operator. If the time be not pressing,
and the surgeon be favored with nimble and practiced fingers, the union by
sewing is the method *par excellence* for adoption. It is impossible, how-
ever, to indicate any one measure as proper for universal employment. The
securing of the greatest good to the greatest number invites and encour-
ages the adoption of the means
best fitted for the case in all
respects.
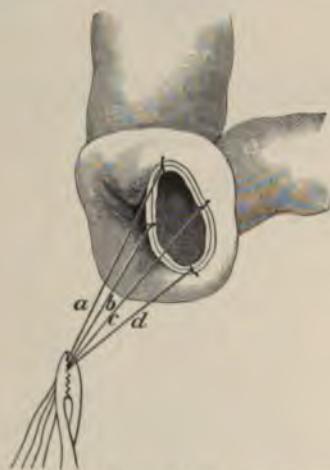
Fig. 997.—Lateral implantation, Maun-
sell's method. Borders invaginated.
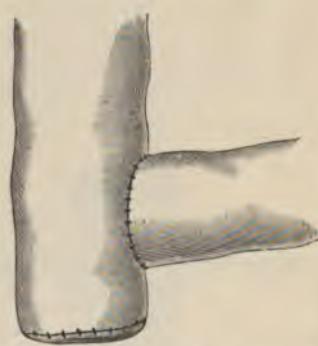
Fig. 998.—Lateral implantation, Maun-
sell's method. Openings closed, sew-
ing completed.

Abdominal Section for Wounds of Abdominal Viscera.—Penetrating
wounds of the abdominal viscera, due to gunshot and other forms of vio-
lence, are of frequent occurrence in civil life. The hollow viscera suffer
most frequently, and the evil effects incident to their injury are prompt,
pronounced, and self-evident. Hæmorrhage due to severance of important
vessels, and peritonitis dependent on the escape of irritating and infecting
agents into the peritoneal cavity, are the deadly factors against the influ-
ence of which the wisest surgical contention so often proves of but little
use. The inability to promptly remove these agents, or master all their
influences, often causes the efforts of the surgeon to appear useless, or even
destructive, to untutored observation. However, the increasing number of
favorable results in heretofore hopeless cases, following prompt, aggressive,
aseptic procedure, have transferred a mere hope of success, based on last
resort, to the field of established surgical action.

Abdominal Section in Penetrating Gunshot Wounds.—The early dangers
in this form of injury relate to hæmorrhage and peritonitis in the order
mentioned. Hæmorrhage is arrested here as in other parts of the body,
although with greater difficulty on account of the number and complexity
of the structures involved. For the proper treatment of this variety of
wound it requires, in addition to thorough aseptic procedure, a knowledge

of the point of entry and the size and direction of the missile, facts which should be carefully ascertained before operation, if time and opportunity will permit. The point of entrance to the peritoneal cavity is ascertained best and safest by means of a careful dissection made in the course of the bullet. The too common practice of exploration of the wound with an uncovered finger or a probe should be either very carefully employed or avoided entirely, since it is frequently unavailing and even injurious from the first, and may cause the introduction into the walls of the wound and into the peritoneal cavity itself of foreign bodies and infecting influences.

The Abdominal Incision.—Whether the incision should be made at the median line of the abdomen or at the seat of the injury is a matter largely controlled by the situation of the point of entry and direction of the missile, the presence of hæmorrhage, and also the personal preference of the surgeon. If symptoms of hæmorrhage be present, the median incision offers the best opportunity for the detection and arrest of bleeding points and the removal of blood from the peritoneal cavity. If the direction of the abdominal wound, irrespective of the point of entry, denotes that the ball has gone toward the median line, the median incision is indicated. However, if this point be outside the borders of the rectus abdominis, and the course of the missile be obliquely outward, instead of backward, upward, or downward, and symptoms of hæmorrhage be absent, a vertical incision at the point of entry may suffice. Finally, it should not be forgotten that rapidity of action and unobstructed observation are the essential requirements for the prompt detection and arrest of bleeding points, as well as for the detection and closure of intestinal wounds. Therefore, an embarrassing or ineffective incision should be promptly supplemented by a better one when circumstances will permit. In either instance the incision should be of sufficient length and so directed as to facilitate the requirements of the procedure. The borders of the incision are held widely apart by means of suitable retractors or by traction sutures passed through their entire thickness.

Ordinarily the free separation of the borders exposes to view the omentum marked with evidences of traumatism, as exhibited by the presence of extravasated blood, and perhaps of bleeding points. If the wound be a simple one, the bleeding points are closed by silk ligatures and the omentum is turned aside so as to expose to view the blood, escaped intestinal contents, and intestinal wounds that may be contiguous to it. Blood and foreign matter thus exposed should be carefully removed by wiping with soft sponges or wipers, which are changed or thoroughly purified after each act of cleansing.

The Detection and Arrest of Hæmorrhage.—Usually any considerable hæmorrhage will have ceased before the opportunity for operation arrives, either by Nature's efforts or the death of the patient. If there be reason to believe that dangerous bleeding still continues, prompt measures for its arrest and treatment of the patient (page 120, vol. i) should be instituted. On the other hand, if only insignificant bleeding be present, the examination for intestinal wounds should begin at once, and the bleeding points should be arrested as soon as found. The search in the abdominal cavity for bleeding vessels and the control of hæmorrhage is a perplexing matter,

especially if the demand be urgent and intestinal wounds be apparent, and
for the time irremediable. We are disposed to advise in such cases that
pressure upon the aorta by means of the hand passed upward through the
wound to the diaphragmatic opening for that vessel, should be made at
once to arrest the hæmorrhage; and, if admissible, that the pressure be
maintained until the intestinal wounds are at least temporarily closed,
after which the bleeding points can be secured without the danger of
further peritoneal infection from this source.

Hæmorrhage from wounds of the stomach or intestine (when empty),
the mesentery, and serous surfaces generally, can usually be well controlled
by means of large, fine sponges or wipers pressed into place and held there
by the hand of an assistant, while the surgeon cautiously releases them in
order from below upward, catching and closing the bleeding points with fine
silk thread as they appear. The bleeding points can be secured by direct
ligation as in other tissues of the body, or by transfixion and tying, trans-
fixion being the more expedient in mesenteric wounds. In the latter in-
stance, however, the inclusion of vessels other than the injured one may
cause localized gangrene of the intestine. *Murphy* has demonstrated on
dogs the importance of their parallel artery (page 800). Digital control
in visceral repletion is safer since in wounds of hollow viscera great care
should be exercised not to force the contents out upon the surrounding
tissue for apparent reasons. If hæmorrhage be due to injury of the solid
viscera, the expedients of relief will be somewhat different and likewise
urgently demanded. Hæmorrhage from the liver is arrested either by
closure of the wound, by sewing, by actual cautery, or by tamponing with
iodoform gauze (page 974); the spleen and kidney may be treated in a sim-
ilar manner, or the bleeding points clamped for temporary control and the
wounded organs removed later, if necessary, for the arrest of hæmorrhage.

The Search for Intestinal Wounds.—The search for intestinal wounds
must be conducted with great caution, and with the aid of a good light
(Figs. 110, vol. i, and 999, *o*), otherwise one or more may pass unobserved;
and fæcal infection, due to escape of intestinal contents, will follow incau-
tious handling. After proper control of hæmorrhage, the loop of intestine
nearest the point of peritoneal perforation is carefully raised and examined,
beginning farthest from the course taken by the missile, passing along and
closing each opening as soon as found with a suitable clamp (Fig. 999, *b*
and *k*), or, better still, perhaps, securing them for the time with pressure
forceps, and giving them in charge of an assistant. Any infecting material
or blood should be wiped away as soon as noted. If it be necessary to
remove the intestine from the abdomen for examination, it should be quickly
surrounded with rubber tissue covered with aseptic gauze saturated with
hot saline solution, and kept thus protected during examination and until
returned.

The Comments.—If the escape of intestinal contents has already hap-
ied careful moist wiping or a gentle stream of the saline solution is
ised to flow continuously across the examination field, thus washing away
'ous products. The accidental passage of some of the fluid
lds need not be regarded with special fear of further

infection, for in such cases abdominal irrigation is commonly employed as a protective measure. The warmth of the fluid exercises a salutary effect on the injured tissues and on the patient as well. We are of the opinion that it is better to temporarily close the intestinal wounds than to treat them finally as soon as found. By the former method they are secured before the height of peristaltic action, excited by the exposure and handling, is attained. This is a manifest advantage, since the peristaltic not only changes the comparative relations of the openings, but also causes further escape and dissemination of infecting agents. To each of the retaining clamps a string should be attached, one end remaining without, to serve as a guide to the intestinal wounds. If, after thus securing the openings, the condition of the patient will warrant, it is better to eliminate at once from the peritoneal cavity, by means of hot saline or sterilized fluids, all blood clots and infecting matter, rather than to risk the danger of more extended dissemination of these products, due to increased peristalsis and unavoidable manipulation. It is difficult indeed to express the proper degree of haste to be exercised, except by saying that each case must be treated in accordance with its own demands, always remembering that an undetected perforation will of itself almost certainly destroy the patient. During the handling of the intestine, the coils adjacent thereto should be carefully protected from all deleterious influences by broad aseptic sponges and pads, or rubber tissue.

The average number of perforations in a gunshot wound of the intestines is between five and six. Contused and lacerated gunshot wounds of the bowel require the same consideration as the penetrating. The use of hydrogen gas for the discovery of intestinal perforations is strongly advocated by Senn. In common with many others, the author is not disposed to advise its employment in the general manner advocated by that eminent surgeon. The intestinal distention thus caused, together with the liability of extrusion into the peritoneal cavity of infecting intestinal agents, may be regarded as strong objections to this method of practice. However, the author can commend its employment when it is addressed to a limited portion of the intestineal tract, for the purpose of detecting not the first, but rather the last, or as yet an undiscovered perforation.

The Repair of the Intestinal Wounds.—The proper repair of the intestinal wounds requires an anatomical knowledge, at least, of the visceral attachment of the mesentery. The two layers of the mesentery separate as they approach the jejunum and ileum, forming a triangular-shaped space about three fourths of an inch long, with a base about a fourth of an inch wide, which is formed by the uncovered muscular coat of the intestine. This space contains fat, delicate fibrous tissue, and the vessels and nerves of the intestine (Fig. 939). If care be not taken in sewing the intestine at the mesenteric border (Fig. 1019), especially in the use of the Lembert suture, imperfect apposition of the borders at that point will be followed by the escape of intestinal contents into the triangular space and thence into the peritoneal cavity (Fig. 939). The terminal parallel branches of the superior mesenteric artery are found here, each running directly to a more or less independent area of intestinal distribution, the shortest branches—

one third of an inch long—being at the termination of the ileum. Since
these branches arise from the final loops of the mesenteric artery and are
comparatively independent of each other, the loops should be treated with
great consideration, otherwise the nutrition of the intestine may be im-
paired. *Murphy* has shown that the parallel artery of the dog's bowel will
nourish for forty-eight hours six and a half inches of intestine when the
straight branches that supply it are tied. However, if the circulation of
this and the corresponding straight terminal vessels be arrested by ligature,
gangrene of the intestine will ensue if the circulation of more than half an
inch of the intestine be involved.

The thickness of the muscular coat of the intestine varies in different
subjects and in different parts of the organ, being thickest at the upper part
of the jejunum—one twentieth of an inch—and thinnest at the lower por-
tion of the ileum—one fortieth of an inch. The submucous fibrous tissue
is an important element of strength in sewing, since it is tough and imper-
vious to air or water. The importance of including it within the stitch,
and its proximity to the mucous membrane and glands within the intestine,
emphasize the necessity of cautious technique in sewing, to obviate involve-
ment of the intestinal lumen. *Halsted* emphasizes these facts profoundly.
Cambric needles armed with colored silk should be employed for intestinal
sewing (Fig. 999, *e*). These needles separate rather than sever the tissue,
thereby limiting the liability to hæmorrhage, and providing a small, firm
stitchhole. The use of colored silk enables the surgeon to quickly distin-
guish the sutures and the silk thread as well. Fine aseptic thread of any
variety of texture can be employed in cases of emergency.

The special importance of the intestinal wounds relates to their nature,
size, contiguity, and situation. Lacerated and contused wounds character-
ize gunshot injuries of the intestine. If the impingement be but trifling, a
contusion is caused; if greater, laceration ensues with or without penetra-
tion; if the latter happen, the intestinal mucous membrane protrudes.
Size and contiguity are important elements, since wounds of large size and
contiguous to important structures often require sterner measures of
treatment than do their antitheses. The situation of the intestinal wound
is of major importance, and often measures the distance between simple
expeditious operative procedure and the reverse of this practice.

In the repair of the intestinal wounds a strict aseptic *régime* must be
practiced: abundant sponges, gauzes, hot saline, and medicated solutions
must be prepared and at hand. Numerous aseptic towels moistened with
aseptic fluids should environ the immediate seat of the operation and be
changed whenever soiled. It may be well to repeat that active sponging
of a serous surface, and the application thereto of solutions of corrosive
sublimate or carbolic acid, produce a traumatic effect on the epithelium
which not only provokes inflammatory action, but impairs the physiologic
functions of serous structures, thus hastening the onset of deleterious
processes and weakening the power of resistance and restoration. The
portion of intestine undergoing repair is isolated by means of soft, flat
sponges wet with the hot saline solution, or by gauze pads (Fig. 73, page
63, vol. i) similarly treated. Infecting agents are carefully wiped away

FIG. 999.—Instruments employed in intestinal repair.

a. Scalpel and bistouries. *b*. Forcipressure. *c*. Needle forceps. *d*. Scissors. *e*. Needles threaded with colored silk. *f*. Rubber tissue around wicking for drainage, and a piece of rubber tissue. *h*. Glass and rubber drainage tubes. *i*. Sponge-holder. *j*. Tenacula. *k*. Clamps for intestinal openings. *l*. Dissecting and mouth-tooth forceps. *m*. Rubber band and catgut. *n*. Sponge with string attachment. *o*. Electric light. The *acetylene light* now bids fair to excel all others for this purpose. Openings are cut in drainage agents to suit the operator.

by a soft, clean sponge or wiper; the intestinal contents are pressed away from the opening and retained by agents devised for the purpose (Fig. 1006), or by the thumbs and fingers of the surgeon, or by an assistant (Fig. 1009), who thereafter carefully holds the intestine, with the lumen compressed in a convenient manner for the operator.
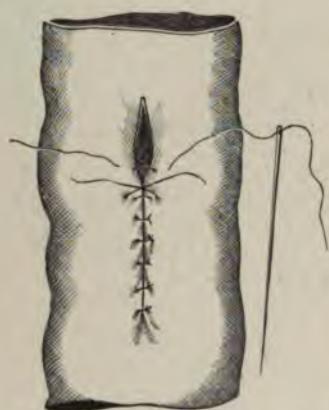
FIG. 1000.—Lembert's interrupted suture.

After inversion of the protruding lips of the wound, penetrating wounds, at all aspects of the intestine except the mesenteric border, can be properly closed by the continuous suture of Dupuytren or Cushing (Figs. 909 and 910), the latter being the more hidden when drawn in place. The interrupted sutures of Lembert (Fig. 914) and Halsted (Fig. 919), while equally efficient, are less quickly applied than the continuous varieties. Interrupted sutures are placed from a sixth to a tenth of an inch apart, and should include, like the other varieties, the submucous fibrous tissue of the bowel. Not infrequently two rows of sutures are applied; the first is interrupted, the last is usually continuous, and penetrates the tissues less deeply than the former, which, when tightened, it entirely obscures. As already stated (page 754), less importance is now attached to intestinal stitch perforation than formerly. After closure the surface is sopped clean with the saline fluid or sterilized water, and a small amount of iodoform is sometimes applied with the finger along the line of union. The contused wounds should be treated in the same manner as lacerated wounds, because the contused portion is liable to slough and expose the patient to peritonitis and all of its dangers. *Either longitudinal or transverse closure of an intestinal wound can be practiced;* the former, however, should not be employed at the mesenteric border, or elsewhere when the lumen of the
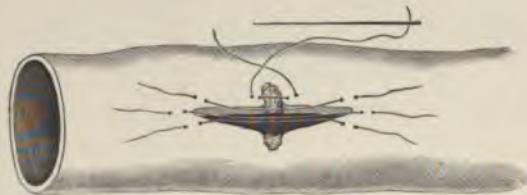
FIG. 1001.—Longitudinal division of transverse defect.   Sutures placed for union.

bowel is reduced by the sewing to less than one half of its norml size (Senn), and even then on the whole it is wiser to resect if circumstances will justify the act. Transverse sewing interferes with the nutrition of the bowel less than the longitudinal, especially when contiguous to the mesenteric border. If this border or the mesentery be wounded so as to destroy the cir-

culation, resection of the intestine corresponding to the seat of the injury must be practiced on account of the imminent danger of sloughing. A limited injury may be repaired by transverse sewing, supplemented perhaps by the union of the ends and borders of a longitudinal incision (Fig. 1001), so as to cause moderate bending or elbowing of the gut (Fig. 1002). If a large opening, or a slough, or numerous

FIG. 1002.—Transverse sewing for repair of defect. Longitudinal division of defect turned in, causing slight elbowing.

contiguous injuries of this nature be present at the free border of the intestine (Fig. 1003), proper repair can be consummated by the process of "elbowing" (enteroplasty, page 820), either with or without removal

FIG. 1003.—Repair by decided elbowing. a, b, c. Borders of defects trimmed.

of the damaged tissue. An incision two or more inches in length, according to the area of the injury, is made lengthwise in the gut, the center corresponding to that of the injury (Fig. 1001). The latter is then repaired at either side of the incision by sewing (Fig. 1004), after which the bowel is bent or "elbowed," so as to bring corresponding portions of the longitudinal incision in contact with each other, in which position they are united. This plan turns the defects inward and still maintains a proper sized lumen, thus obviating the necessity of resection of the intestine, a manifestly dangerous alternative in the presence of inexperience and pressing demand. Elbowing should not be practiced at the mesenteric border on account of the operative difficulty, the danger of sloughing attending

FIG. 1004.—Repair by decided elbowing. a, b, c. Borders in position for sewing.

56

it, and also the liability of subsequent kinking of the gut, none of which conditions are pronounced in convex-border elbowing.

Chaput advised stitching over the area of an impending perforation the surface of a contiguous intestine. This is an ingenious proposition, and may no doubt prove effective under special contributing circumstances.

In wounds of the omentum and mesentery hæmorrhage is arrested, the borders of the wound are inverted, and the opening is closed by sewing. If the omentum be greatly damaged, or if it and the mesentery are infiltrated with blood, the omentum is removed at the seat of injury after ligature with silk and any opening in it closed, and the wound of the mesentery is closed after the evacuation of the extravasated blood and the arrest of hæmorrhage.

Resection of the Small Intestine (Enterectomy).—In those cases in which the injury is too extensive to admit of simple means of repair, or the circulation of the mesenteric border is destroyed, or extensive disease has taken place, etc., the removal of a portion of the intestine becomes necessary. The amount to be removed may vary from half an inch to many feet. In cases of multiple injury of the intestine, it is wiser to perform a single enterectomy, even though a limited amount of uninjured intestine be sacrificed, than to practice double enterectomy with the view alone of saving a greater amount of intestine, for the unfavorable influence of time and exposure on the final outcome of the case is of greater significance than the sacrifice of the intervening uninjured portion of the bowel.

a   *b*
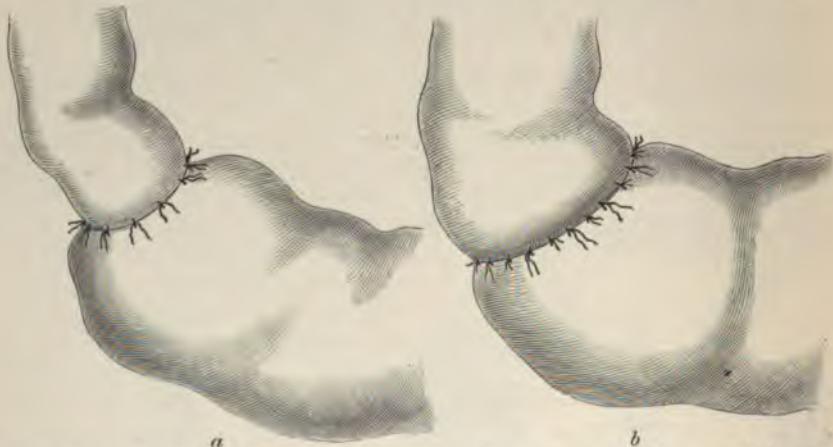
FIG. 1005.—The effect of distention on union with interrupted suture. *a*. Before distention. *b*. After additional sutures added.

The resection of intestine is not a difficult procedure, but the repair of the resulting wound is quite another matter. Milliners' needles (Fig. 999, *e*), with points sufficiently blunted to permit easy recognition of the piercing of the submucous fibrous coat, armed with fine twisted aseptic colored silk, are the best for sewing. When circumstances will permit two lines of sutures are usually employed, one the interrupted, the other the continuous

variety, the last of which is outermost and properly causes concealment of
the former. Both should be cautiously tightened so as not to strangle the
included tissues. Differently arranged sutures used combinedly give greater
security than do similarly arranged ones. *The interrupted suture permits
distention at the seat of sewing* (Fig. 1005), *the continuous* hinders it; the
interrupted contributes but little to contraction, the continuous much,
unless great care be exercised in its introduction; the integrity of the union
by the interrupted is often practically affected by changes in caliber of the

FIG. 1006.—Means employed to restrain intestinal contents. *a.* Self-closing forceps,
blades protected by rubber tubing. *b.* Billroth's clamp. *c.* Murphy's clamp.
d. Maunsell's safety pin and sponge clamp. *e.* Jeannel's rubber tube and forcipres-
sure clamp. *f.* Heinake's clamp. *g.* McLaren's clamp.

gut, that of the continuous is made insecure by subsequent contraction;
infection by capillarity is limited in the interrupted to perhaps a single
stitch, in the continuous it may invade the entire length; interrupted
stitches are cast off independently of each other, the continuous suture
remains until the final stitch is liberated.

It is apparent, therefore, that these varieties serve well together and
that the continuous suture should be applied last. The pushing aside of
the contents of the intestine and the prevention of the return during repair
are matters of great importance. This purpose can also be accomplished
by means of narrow strips of iodoform gauze passed around the gut
through an opening made at the border of the mesentery, and tied (Fig.
937). Rubber bands (Fig. 1011) may be employed in a similar manner
(Senn). Flat pieces of sponge wrapped around the gut and having their
ends pinned together with a safety pin passed so as to include the border

of the mesentery (Maunsell) (Fig. 1006, *d*), are efficient. Finally, though less effective and convenient, the fingers and thumbs of an assistant may

be called into use for this purpose (Fig. 1009). Various measures are advised to properly control the extremities of the intestine during the act of sewing. The introduction of traction loops at points a short distance from the respective ends (Fig. 1007), in such a manner as to cause parallel ridges through which the needle can be readily passed, is an effective and ever available means.

Kocher's Method of Resection.—Draw well out of the peritoneal cavity the portion of intestine to be removed, exposing healthy intestine for a
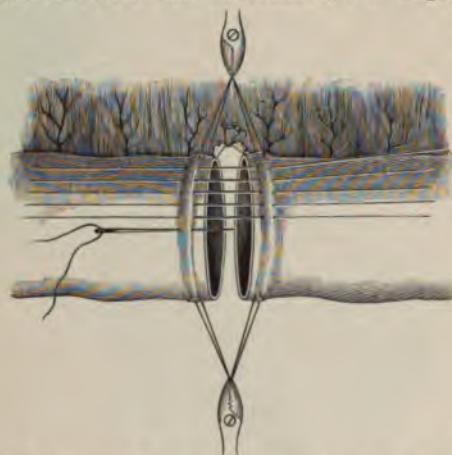
Fig. 1007.—**A** method of control of the ends in intestinal sewing.

convenient distance at either end of the impaired part; pack carefully around the exposed bowel soft sponges or gauze saturated with the hot saline solu-
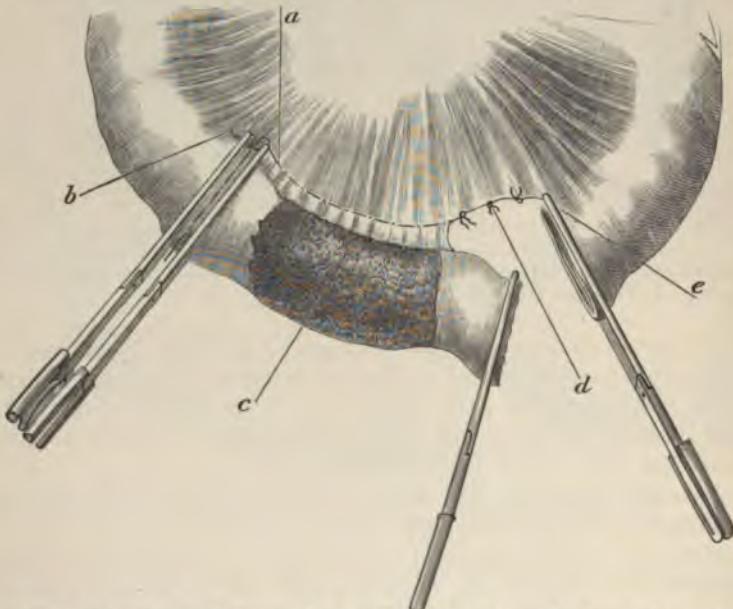
Fig. 1008.—Resection of the small intestine, Kocher's method.   *a.* Line of division of omentum.   *d.* Sutures applied.   *b, e.* Oblique line of section.   *c.* Diseased area.

tion, so that any further peritoneal infection will be prevented; press away from the resection area with the thumbs and fingers the intestinal contents,

and at the limits of displacement apply suitable clamps (Fig. 1008) to the intestine at right angles with it or with outward divergency (Fig. 1008, b, e) so as to obstruct the lumen of the gut and prevent the return of the
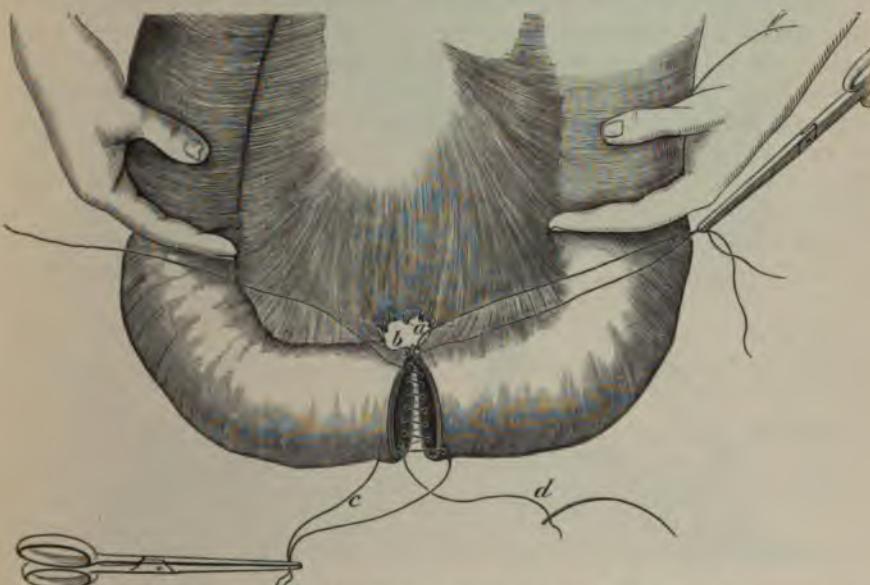
FIG. 1009.—Resection of intestine, Kocher's method.   b. Tied border of mesentery.
a. First fixation suture.   c. Second fixation suture.   d. Posterior continuous suture.

contents to the evacuated area.   Divide the intestine at right angles with its long axis or with slightly outward divergence through well-nourished structure at points about three quarters of an inch inside the clamps with blunt-pointed scissors; sever the mesentery from the wall of the bowel with

scissors passed along the base of the interperitoneal triangular space, catching the bleeding points as they appear, thus relieving the excised portion from its attachments and allowing it to fall away with each extremity securely clamped. Cleanse the parts thoroughly, substitute fresh packings, ligature the mesenteric vessels, and turn in and sew with continuous suture the border of the mesentery (Fig. 1008). Then bring the ends of the divided bowel near together, pass a fixa-
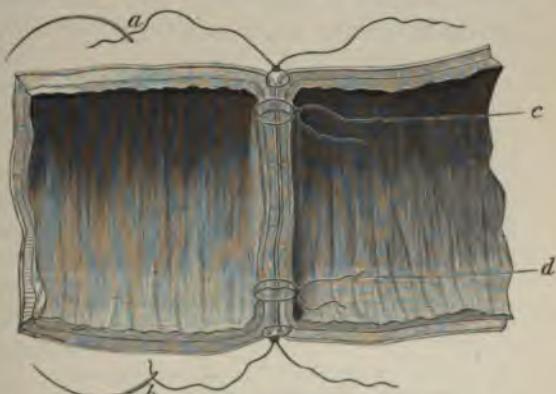
FIG. 1010.—Resection of intestine, longitudinal section, Kocher's method.   a. Anterior serous suture knotted.   b. Posterior serous suture knotted.   c. Deep suture, mesenteric attachment.   d. Deep suture, free border.

tion suture through the sites of mesenteric attachment of both (*a*), and another through the opposite borders at their extremities, to secure accurate apposition of corresponding parts of the intestine (*c*). The fixation sutures do not pass through the intestinal wall, but include the serous and muscular structures of the intestine only, and when pulled on in opposite directions closely approximate the divided ends throughout. A continuous sewing (fixation) is now begun at the mesenteric border, including the entire thickness of the intestine, and taking a wider grip of the serous than of the mucous layer (Fig. 1009). The first loop of the suture is tied and the passive end left long for subsequent use (*d*). Then, beginning behind, the borders of the gut are united firmly together by a continuous suture formed of the remaining

FIG. 1011.—Resection of intestine, Halsted's method. Rubber bands and presection sutures in position.

end of the loop, and passing through the entire thickness of the walls of the divided ends around their entire circumference, finally being tied with the passive extremity, thus firmly and securely closing the intestinal canal. Cleanse the line of suturing and also the exposed intestine, and provide fresh packings if necessary. Then, commencing—knotting, as before—at the convex border (*b*, Fig. 1010), introduce an external posterior suture

FIG. 1012.—Resection of intestine, Halsted's method. Presection sutures tied.

along the line of the deep one, including the serous and muscular coats only, tying it finally to the passive extremity of the anterior suture (Fig. 1010, *a*). Then carry the anterior suture around the remainder of the bowel, finally tying it to the free end of the posterior suture (*b*). The opening in the mesentery is closed by sewing together its borders, or by folding and stitching it in place. The parts are then cleansed with hot saline solution, the packing is removed, and the intestines are returned to the abdominal cavity. Although the mucous membrane protrudes freely after division of the intestine, the

protrusion should not be trimmed, the first row of stitches being preferably inserted there. Two additional external rows are often applied, the first the interrupted, the second and final the continuous form. If the patient's condition requires prompter action, the last two only need be employed.

Fig. 1013.—Resection of intestine, Halsted's method. Halsted's mattress sutures placed.

Halsted's Method of Resection.—The portion to be resected is isolated as in the preceding instance, and the contents are pushed aside and retained by rubber bands carried around the intestine and fastened by looping (Fig. 1011). The lines of incision are so directed as to secure for each end of the bowel free arterial supply which is carefully protected throughout from injury. Before removal is begun "presection" sutures, usually six in number, are introduced, just outside of the proposed lines of division in the manner indicated in the illustration. These sutures serve to bring the ends together (Fig. 1012), thereby

Fig. 1014.—Resection of intestine, Halsted's method. Sutures tied.

facilitating the final sewing. The mattress sutures are now introduced, piercing, but not passing through the submucous fibrous coat, and tied (Fig. 1013). The slit in the mesentery is cautiously closed so as not to impair the vascular supply of the intestinal extremities (Fig. 1014). Halsted advises that the sewing be done over a rubber bag which is introduced between the "presection" sutures and carefully inflated. He claims for this measure the attainment of a higher order of work.

Some years ago Treves devised a plan akin to this which he subsequently discarded. For further description, see Philadelphia Medical Journal, January 8, 1898.

Harris's Method of Circular Enterorrhaphy.—After resection of the desired portion and proper isolation and cleansing of the parts, Harris unites the divided ends in the following ingenious manner: Thread each of three needles with fine silk; remove the mucous membrane from the distal

end of the gut for about three fifths of an inch with a sharp curette, being sure to destroy the glands; transfix at one side of the mesentery at the inner limit of denudation the denuded end of the bowel with a needle; cause the point of the needle to project from the caliber of the bowel a little beyond the free edge (Fig. 1015); pick up transversely with the point of the needle (a), just to one side of the mesentery, close to the proximal end of the bowel, a portion of its wall; draw the needle back slightly, and turn the point backward and round so as to invaginate the upper into the lower end, to the point of the lower limit of denudation, then pin it there by
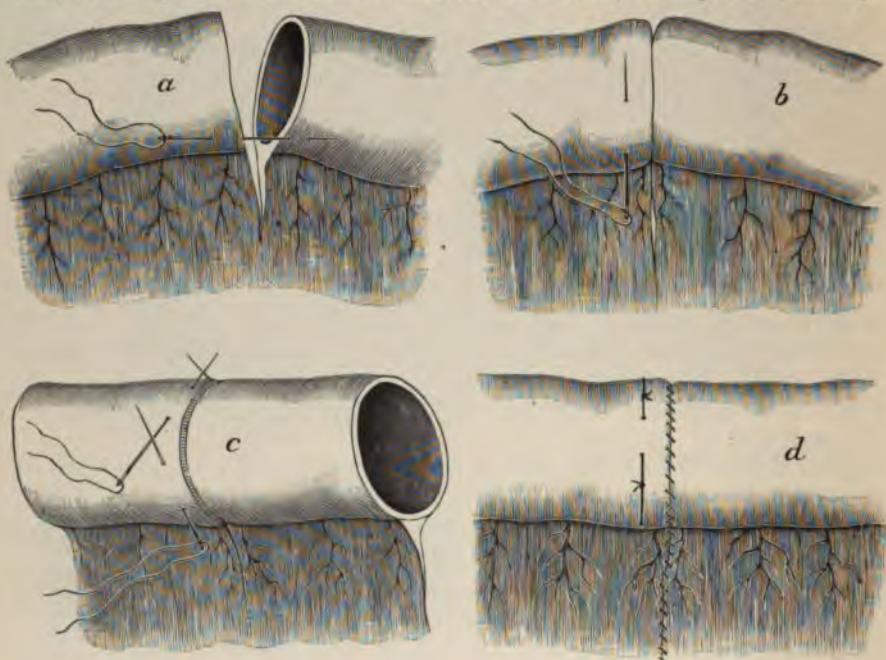
FIG. 1015.—Circular enterorrhaphy, Harris's method.

piercing transversely the coats of the distal end (b); repeat with the second needle the same action at the corresponding point of the opposite side (c). The portion opposite the mesenteric attachment is treated in a like manner with the third needle (c). The needles are then carried through, the stitches tied, and permanent fixation is established (d). The exposed end of the bowel is then sewed to the invaginated part with interrupted or continuous sewing, preferably the former, as less liability of contraction is encountered. This method of practice is well conceived, always available, can be quickly applied, and thus far the use has been followed by commendable results.

The use of the Murphy button, the bone bobbin, Coffey's " Crushable " potato bobbin, etc., or Maunsell's method, in lieu of the stereotyped end-to-end union by sewing, will, no doubt, be advantageous in many instances. The surgeon who makes a wise selection of one of many resources is possibly

a safer custodian of human life than one who is wedded to a single expedient, even though it be of his own creation.

The Treatment of the Mesentery.—Several methods of management of the mesentery are practiced: 1. Its division close to the bowel (Figs. 1008 and 1016), the folding in and union of the border by continuous sewing,

FIG. 1016.　　　　　　　　　　　　　　　　FIG. 1017.

FIG. 1016.—Resection of intestine, rubber bands applied. *a.* Mesentery ligatured, divided, and ready to turn aside (Fig. 1017). *b.* V-shaped piece sometimes removed along with diseased area.

FIG. 1017.—Resection of intestine, mesentery turned aside and borders united.

and final closure, by sewing, of the opening left after uniting the intestinal extremities (Fig. 1017). This method is one commonly practiced. It has been suggested that the redundant fold be turned to one side and fastened to the overlapped surface by a few silk sutures placed at the borders of the folded portion (*a*). 2. The removal of a triangular piece (Fig. 1016, *b*) of the mesentery along with the portion of bowel and the stitching of the sides of the triangle to each other after sewing of the intestine (Fig. 1018).

Ordinarily, the sides of the triangle should not exceed the length of the base, but in operations for malignant disease of the intestine, for which this method is especially adapted, attended with enlargement of the mesenteric glands, the extent of the outlines of the triangle may be governed by the extent of the disease. This method leaves a smooth mesenteric surface, equally distributes intestinal movements, and is artistic in its finish. Still, it is thought to inter-

FIG. 1018.—Resection of intestine. Union of borders of mesentery, Halsted's method.

fere with the vascular supply of the gut more than the preceding method. 3. The removal, along with the mesenteric border, of a strip of the serous coat of the intestine to be excised, about half an inch in width

at either side of the mesenteric attachment, and closure of the resulting loop by sewing the same as in the first instance. This method is more ingenious than practical in its bearings. *Mitchell* and *Hunter* have devised an admirable stitch for the purpose of properly apposing the serous membrane to the uncovered part of the bowel at the base of the triangular space of the mesenteric attachment (Fig. 939), which at the same time adds much indeed to securing end-to-end union of the intestinal segments, thereby contributing greatly to the prevention of fæcal extravasation (Fig. 1019).

The Comments.—Having completed the repair, the parts are carefully cleansed, returned to place, and the abdomen is closed. In some instances, however, especially those in which for any reason the intestines are over-distended and oppose return and confinement in the abdomen, their contents should be discharged through one or more free incisions made at proper points in the longitudinal axis of the gut with a scalpel. These
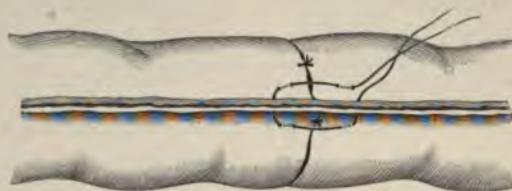
FIG. 1019.—Mitchell and Hunter's suture for closure of attached border of mesentery.

incisions can be easily closed by intestinal sewing. *McCosh* practices the injection of a solution of magnesium sulphate into the bowel, before closure of the incisions, with excellent results. *Hotchkiss* introduces the magnesia into the stomach after washing out to ameliorate the vomiting following anæsthesia. Puncture of the intestine with a trocar is much less effective and quite as dangerous as the free incision. The spreading over the intestines and carrying beneath the borders of the wound an aseptic towel, thereby forming an extemporized wall for the better return of the distended intestines to the abdominal cavity, is a practical measure highly commended by Murphy. The raising upward with traction sutures of the borders of the abdominal incision, thereby forming a funnel-like opening, is often soon rewarded by safe return of the distended bowels. The toilet, drainage, and closure of the abdominal cavity has been considered already under the head of Abdominal Section (page 745 *et seq.*).

The Precautions.—If the condition of the patient will permit, overdistention of the intestine from any cause should be relieved through an incision into the injured or diseased loop before resection is attempted, to avoid the greater changes of infection incident to the presence of the distention during repair, and also to secure the manipulative advantage of its absence at this time. The thorough elimination of the contents of a distended intestine by means of free irrigation of the cavity of the bowel with the hot saline solution is to be commended when practicable. Punctures made for the purpose of eliminating the gas from an overdistended intestine

should be promptly closed with a suture—in fact, it is wise that the suture intended for this purpose be laid and pushed aside before the puncture is made, otherwise the paralyzed and overdistended state of the bowel wall will permit of precipitate escape of the contents. While the stereotyped abdominal incisions usually meet the demands of a case, still, it is important to remember that their extent and direction should conform to the demands of close inspection, prompt manipulation, and thorough elimination of infecting agents from the abdominal cavity. Flushing of the cavity for removal of blood clots, intestinal contents, etc., is commendable, except in the presence of circumscribed infection (page 745), then flushing is likely to cause diffusion instead of elimination of infecting agents. In any event, in established localized infection, thorough wiping away of this infection should precede flushing.

The Results.—The modern methods of procedure in gunshot wounds of the abdomen result in about sixty per cent of recoveries, as compared with ninety-five per cent of deaths following the old non-operative, expectant method of treatment. Twenty per cent greater rate of recovery attends operations made during the first five hours of the injury than in those made from five to fifteen hours later. The results of intestinal resection for chronic causes—those not attended with the acute peritoneal infection that so often characterizes gunshot wounds—are better than for gunshot wounds alone, and may yet be much improved by earlier diagnosis and prompter operative effort. The Mauser weapon is less fatal than the older arm.

Gunshot Wounds of the Duodenum.—Owing to the intimate relations to the duodenum of the stomach, pancreas, liver, etc., wounds of this bowel are often complicated with injury of the contiguous viscera, and therefore are correspondingly dangerous. Wounds of the duodenum alone are not so critical as those of the smaller intestines, since the upper two or three inches of this portion of the bowel are intraperitoneal, the lower two thirds being covered only in front by this membrane. Wounds of the upper part of the duodenum are treated like those of other intestines similarly associated with peritonæum. A wound of the surface uncovered with peritonæum, as at the lower two thirds of the gut, should be closed with great care, scrupulous cleanliness, and reinforced, if possible, by the utilization of adjacent serous covering so as to bring serous surfaces in contact the same as elsewhere in intestinal sewing. Wounds of the posterior surface of the lower two thirds of the duodenum are obviously retroperitoneal in character, and therefore less immediately dangerous than when communicating directly with the peritoneal cavity. However, repair here is difficult on account of the absence of serous surfaces; on the other hand, infection is greatly hindered for this reason, and drainage can be established posteriorly without involvement of the serous cavity in front, if necessary. Unless painstaking care be exercised, penetrating wounds of non-serous surfaces will escape notice.

Gunshot Wounds of the Large Intestine.—Wounds of the large intestine are less frequent and fatal than are those of the small. Wounds of the transverse colon are more fatal than those of the ascending and descending portions, because of its greater peritoneal environment. Wounds of the

large intestine can be divided practically into those involving the serous and those involving the non-serous surfaces of the gut. The former are closed the same as in the small intestine; the latter in the careful manner that characterizes the sewing of non-serous surfaces of other parts of the intestinal canal (page 799 *et seq.*). The introduction into the bowel of ordinary air by means of an old-fashioned bellows, or by blowing, even, through a rubber tube with one end in the rectum, can be employed for detection of obscure wounds of the colon in lieu of insufflation with hydrogen gas. In uncomplicated wounds of the large intestine an incision in the median line is usually not necessary. A vertical one at or near to the linea semilunaris, supplemented when necessary by another carried outward and downward toward the spine, affords ample opportunity for examination and repair.

The Results.—The rate of recovery after operation for gunshot wounds of the large intestine exceeds that of the small by three or four per cent.

The after-treatment in gunshot wounds is not especially dissimilar from that for other grave intestinal operations. The ice-water coil can be applied to the abdomen with advantage in these cases.

Stab Wounds of the Abdomen.—In stab wounds of the abdomen one of the important duties is to determine if the peritoneal cavity has been entered, which is accomplished in the same manner as in gunshot wounds. Not infrequently the escape through the wound of omentum or intestine settles the fact at once. In prospectively estimating the extent of the injury, the nature and characteristics of the penetrating agent, together with the direction and force of the blow, must be determined when possible. The ascertainment of these facts need not take additional time, since it can be rapidly gained during the preparatory steps for the operation, which steps are frequently made the more comprehensive by reason of the knowledge thus gained. The primary incision is commonly made at the seat of the injury down to the point of penetration. All hæmorrhage is arrested, the abdomen entered, retraction sutures are introduced, and the borders of the wound drawn apart with as little disturbance of the underlying structures as possible; the omentum, intestines, and mesentery respectively are carefully examined, bleeding points caught, and wounds closed temporarily, as soon as found; blood, infecting agents, and foreign bodies are carefully wiped away, aided by gentle flushing with a hot saline solution, in the manner already described in the treatment of gunshot wounds of the abdomen (page 796). Severe hæmorrhage is arrested by direct pressure with sponges, or digital pressure on the aorta; the bleeding points are caught and tied with silk. Wounds of other viscera are looked for, if contiguity of the injury or other circumstances of the case suggest the possibility of such a complication. In fact, but few practical differences arise in the treatment of gunshot and stab wounds of the abdomen. The methods of repair are the same in each, but of the simpler types in the latter, owing to the simpler nature of the injury. Punctured wounds of the mesenteric borders of the intestine are united the same as those of the convex surface, unless they be ragged or have impaired the circulation of the intestine in a dangerous degree; then the treatment for gunshot wounds

at this situation is practiced. The care during the operation is in all respects similar to that for gunshot wounds.

The Comments.—A prompt examination to determine the presence of peritoneal penetration should be made, for no harm can follow if penetration have not taken place, and great good may come with the knowledge of its occurrence. The escape from injury of the intestines in stab wounds of the abdominal cavity is, indeed, often marvelous. This good fortune is due almost entirely to the comparative slowness of the entry of the penetrating agent, and its dullness, and also to the mobility of the intestine, especially when empty. The wounds inflicted with broad-bladed or double-edged weapons are especially dangerous, since the cut in the intestine is large, and the escape of intestinal contents and the loss of blood are proportionately great. Profuse and persistent bleeding often attends such wounds as these, and the efforts to arrest hæmorrhage should be conducted carefully to avoid unnecessary spreading of effused intestinal contents.

The Results.—The percentage of recoveries is estimated differently by different authors; from 13 (Dalton) to 39.24 (Morton).

Contused Wounds of the Abdomen.—Contused wounds of the abdomen are often complicated with contusions and lacerations of the intestine. The jejunum suffers most frequently, because of its relations to the spinal column and its comparative immobility. The ileum is next in order of frequency. The duodenum suffers comparatively often when its brevity and retired position are considered. However, its fixity and relation to the spine predispose greatly to injury. The colon as a whole is well protected because of its comparatively secluded position. The ruptures vary in number and extent. In ninety per cent of the cases they are single; in twenty per cent they involve almost, and occasionally the entire width of the bowel (Curtis), the usual dimension being about an inch in length, therefore fæcal extravasation is a common result. Laceration or contusion of the mesentery is a formidable complication, as it happens in about sixteen per cent of the cases, and eighty per cent of these die from hæmorrhage. Inasmuch as the majority of patients die in forty-eight hours after the time of the injury prompt operative interference is demanded. After shock has properly subsided and thorough aseptic preparation for operation is secured, a median incision four inches in length is made, retraction sutures are introduced, and the borders of the incision drawn apart sufficiently to permit of the inspection of the exposed abdominal contents. If needful, this incision can be enlarged upward or downward sufficiently to allow of a completer scrutiny. Gas, intestinal contents, and blood may be noted in the field of observation. If hæmorrhage be pronounced, the bleeding points must be sought for and closed at once, and all intestinal openings temporarily closed with clamps as they appear during the search. Digital compression of the aorta and direct sponge or textile-fabric pressure of the bleeding field should be practiced if necessary, to arrest the outpour of blood. Finding the location of the bleeding site will often be facilitated by removal of more or less of the intestines from the abdominal cavity, in which case they should be surrounded by rubber tissue and supplemented by aseptic gauze saturated with the hot saline solution, and kept thus until returned to

their proper place. Eventration should be avoided when possible. Infecting agents are wiped away with soft, moist, hot aseptic sponges, or washed out with a saline solution, the use of which often stimulates the flagging forces of the patient, and enables the surgeon the better to accomplish his purposes. If general infection of the peritonæum have happened, rapid and copious flushing and cleansing of the peritoneal cavity and the intestines with a hot saline solution should be practiced before completion. This course hastens the final toilet of the cavity, makes it the more thorough, and also balances, in part, at least, by stimulation the ill effects caused by the eventration. However, repair of the defects during eventration should be avoided when practicable, as the need of this course increases the gravity of the case. After the return of the intestines, the repair of lacerated and contused wounds of the convex border of the bowel is made by simple inversion, or limited excision with or without " elbowing " (Fig. 1003) as the extent of the injury may require. Wounds of the mesenteric border of the intestine and of the mesentery itself that compromise the arterial supply of the gut, are followed by gangrene, and therefore enterectomy should be practiced according to the principles and after the manner employed in gunshot wounds (page 796). It is frequently necessary to abbreviate remedial effort by the substitution of a fæcal fistula (enterostomy) for other methods of procedure, in order to avoid imminent danger of death of the patient, applying the final remedy later. However, if the duodenum or the upper part of the jejunum be involved, the practice of enterostomy is soon followed by starvation and death, hence the defect should be promptly remedied if at all feasible. Therefore, the ileum and lower part of the jejunum are the parts best adapted for the establishment of a fæcal fistula. After replacement of the intestines, the necessary measures of repair are performed with the aseptic technique, heretofore advised for the purpose (page 799). The final peritoneal toilet, drainage, and closure of the abdomen differ in no essential respects from that before described (page 745). Contused points of intestine attended with extravasation within the tissue of the gut should be turned in when practicable, and the borders united by sewing; the borders of gaps in the serous covering should be drawn together by fine silk sutures.

The Results.—The results are doubtful at the best, and unfavorable without early action, and even then it is sometimes wiser to make a temporary fistula low down than attempt the performance of a radical procedure.

In 95 cases the mortality from operation was 47 per cent. In those for horse-kick alone about 70 per cent. In 54 cases, those operated on before the twentieth hour, 80 per cent recovered; after this time, but 26 per cent were successful. The average duration of operative interference was an hour in the successful cases, and an hour and twenty-five minutes in the unsuccessful. An occasional death from errors in technique happened. Cases of injury of other structures than the intestines and their associated vessels are excluded from this list. Temporary enterostomy was practiced in four cases, three of which recovered.

Abdominal Section in Intestinal Obstruction.—*It is unusual, indeed, that the services of a surgeon are called for in these cases in time to afford a*

fair measure of success to the patient (see prognosis, etc., page 835 *et seq.*). The uncertainty in diagnosis and the tendency to procrastination rob the patient too often of the benefits of surgical resources. The potent influences of pain, vomiting, loss of sleep, lack of nutrition, and the septic effects of intestinal accumulation and distention, are usually indelibly stamped on the features and vital forces of the patient at the time the surgeon is called. Since it is the duty of the surgeon to save life irrespective of the completeness of a surgical procedure, frequently he must decide between the adoption of temporary enterostomy, with possible recovery, and completed details with probable death.

Enterostomy.—Enterostomy consists in the making of an opening into the small intestine and the temporary or permanent attachment of its borders to those of a corresponding opening in the abdominal wall, for the purpose of relieving the intestinal distention due to obstruction or for the nourishment of the patient. Enterostomy is usually performed at the right side, but it may be done at the median line or the left side. It is established in the median line when it is found to be impracticable to overcome the difficulty in the intestine for which the incision was made and when to establish the opening elsewhere would be inexpedient. The opening under these circumstances becomes an artificial anus.

Kocher's Method (*Fœcal Fistula*).—Make an incision at the outer side of the epigastric artery two inches and a half in length, parallel with and an inch and a half above Poupart's ligament, down upon the peritonæum. Arrest hæmorrhage and make an opening in the peritonæum an inch and a half in length; draw carefully into the opening the presenting loop of *distended* intestine sufficiently to allow only the convex border of the gut to project above the surface of the abdomen; pass a silkworm-gut suture at each end of the wound through all of the tissues at a little distance from the borders, including the serous covering of the gut, thus fixing the loop of intestine and shortening the primary incision. Sutures may be passed similarly at either side of the wound, if advisable. Stitch the wall of the bowel to the divided peritonæum with a continuous silk suture (Fig. 1020); supplement this row with a superficial one of catgut, uniting the integument with the serous and muscular walls of the bowel, carefully avoiding penetration of the gut; smear the wound freely with iodoformized vaseline to prevent the contact of intestinal contents

FIG. 1020.—Enterostomy, Kocher's method. *a.* Parietal peritonæum. *b.* Aponeurosis of external oblique m. *c.* Transversalis fascia. *d.* Intestine.

with the raw surfaces; puncture the protruding loop at the convex border with the point of a scalpel, and direct the escaping substances aside with rubber tissue, or oiled silk, as fast as they escape. No effort should be made to hasten the discharge, nor should the intestinal canal be flushed. After

the vigor of the flow has ceased, wipe the integument dry, smear it with vaseline, cover the wound with an abundance of absorbent cotton or with oakum, which dressing confine in place loosely and change when soiled. If the case be very urgent, the supplementary row of sutures can be omitted. If delay be permissible, the intestine need not be opened so soon, two or three days being granted to first secure firm adhesion of the gut to the borders of the wound. The median incision of an exploratory operation can be utilized in forming an artificial anus, in case it be necessary to desist from further radical procedure. This incision offers the advantages of a definite diagnosis, and the location of the fæcal fistula close to the point of obstruction, which are important desiderata if no further efforts at relief are contemplated. The use of Paul's tube with a rubber tube attachment is advisable (page 825) for the purposes of cleanliness.

The Precautions.—The division of the epigastric artery will be an embarrassing complication. However, as it runs upward and inward from behind the middle of Poupart's ligament, it can be easily avoided by cutting outside of the latter point. Care should be taken to obviate a twist in the presenting loop of intestine for self-evident reasons. It is likewise apparent that the opening of a collapsed intestine will afford no relief. Scrupulous attention should be given to the condition of the patient during operation by one assigned for that purpose, otherwise an unexpected sudden demise of the patient will deepen the responsibility for the case. If the intestine be much distended the walls may be correspondingly thinned, and therefore readily punctured in sewing, causing infection of the deep tissues of the wound and perhaps of the peritoneal cavity itself. A distended cæcum may be mistaken for a distended intestine.

The Remarks.—The opening in the gut should be as small as practicable, to avoid undue prolapse of the mucous lining of the bowel, and to limit the area of subsequent repair. The length of the primary incision will be regulated principally by the thickness of the abdominal walls. If the element of time be unimportant, the borders of the divided peritonæum can be first stitched to those of the integument, thus lining the opening with serous membrane, thereby providing a firmer and securer union between the intestine and the borders of the opening.

The Results.—Not infrequently the establishment of a fæcal fistula cures entirely the original infliction, and later the fæces flow uninterruptedly through the normal channel. The following statistics compiled by Curtis, bearing on the results of enterostomy in acute intestinal obstruction, emphasize the importance of the procedure in no uncertain terms. In sixty-two cases 46 were relieved, 6 unrelieved, and the outcome not stated in 10; 51.7 per cent recovered, and in 60 per cent of the recoveries the fæcal flow resumed the natural channel. Forty-eight per cent died. According to Curtis, the rate of mortality of abdominal section in this class of cases is twenty per cent greater than that of enterostomy, and the benefits of the former do not compensate for greater death rate. The patients unable to endure enterostomy, which can readily be performed under cocain anæsthesia, can not be expected to survive the operation of abdominal section, and the operative remedy under general anæsthesia.

Therefore, a patient rescued at the outset by the safer plan has a subsequent opportunity of cure by the graver method.

The Making of an Artificial Anus (Kocher) in the small intestine differs in an important degree from the establishment of a fæcal fistula at the same situation. The former is a permanent affair and includes the entire width of the intestine, so that all the fæcal matter passes through the opening. It may be established in the groin or in the median line. Up to the time of incision of the peritonæum there is no practical difference in the technique of the two operations. The peritoneal opening is made smaller in artificial anus, the loop of intestine is drawn completely out of the wound, and the proximal extremity placed uppermost before the loop is stitched to the borders of the peritoneal incision with the continuous silk suture (Fig. 1021). The proximal part of the loop is given the most room, and is so arranged as to press on the distal part. Sew the parts and smear them with vaseline, as in enterostomy; open the intestine sufficiently to cause free and complete escape of the contents; cleanse the wound and remove the triangular portion indicated in the illustration. The after-attention is all a matter of cleanliness and nutrition (page 1234).

The Remarks.—It is proper to recall under this heading the fact

FIG. 1021.—Enterostomy, Kocher's method. *a.* Parietal peritonæum. *b.* Abdominal muscles. *c.* Integument. *d.* Diverging lines of division.

that a permanent establishment of the intestine in relation to the external wound requires that the obstruction be low down, and that the opening be made as near to it as possible. Innutrition and even starvation will ensue if an artificial anus be located too near the stomach. If time will permit, the operation can be divided into steps, the final one—the opening of the anus—being deferred until after adhesions have taken place. If the loop withdrawn be distended it should be emptied into a contiguous loop and constricted (Fig. 1013) to prevent return of the contents, thus avoiding the dangers of penetration of the gut in sewing, due to the thinning of the wall dependent on overdistention. The abdominal-wall sutures close to the protruding parts should be clamped until these parts are properly adjusted and then tied. The intestine may be fixed in place in this instance with a glass rod (Fig. 1027, *k*), or by a similar agent, the same as in colostomy, or sutures only may be employed for the purpose. The smaller the protrusion is, consistent with utility, the less is the danger from contamination and of annoyance from friction. Before opening the gut it is often expedient to introduce at either side of the proposed site of entrance traction sutures, thus securing better control of the part during evacuation. The trocar and cannula may be employed, or the glass tubes of Paul (Fig. 1030), the same as in colostomy (page 823).

57

Enteroplasty.—Enteroplasty is an operation commonly applied to the surgical treatment of intestines, without resection, for the purpose of repairing defects in the caliber of the gut (Figs. 1001 and 1002), as in pyloroplasty (page 942 et seq.) by the various methods of elbowing (Fig. 1003), etc. Jeannel elbows the intestine in performing circular enterorrhaphy by making oblique section of the ends (Fig. 1022), his reason therefor being to allow a larger caliber at the seat of union (Fig. 1023),
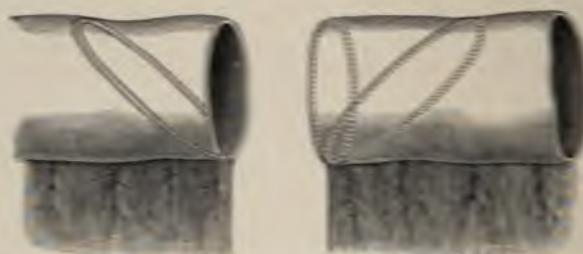
Fig. 1022.—Elbowing in circular enterorrhaphy, Jeannel's method.

to offset the subsequent narrowing from cicatricial contraction. The dangers from kinking are greater in this than in the preceding method (Fig. 1003) ; and, besides, it is less expeditious and in nowise the better plan.

Chaput elbows the intestine by uniting the transversely severed ends, followed by slitting the bowel opposite the mesentery for an inch or more, trimming the corners, and sewing together the borders (Fig. 1024). This

Fig. 1023.—Elbowing in circular enterorrhaphy, borders united, Jeannel's method.

method has no practical advantages over the preceding. Chaput's method of circular enterorrhaphy with oblique incision without elbowing, is accomplished by cutting the ends at an angle with the long axis of the intestine, so as to form an equal ellipse at opposite sides of either extremity of the

intestine (Fig. 1025). The mesenteric involvement in these incisions is not regarded as significant. The union of the ends secures a long oblique line

FIG. 1024.—Elbowing in circular enterorrhaphy and longitudinal slitting, Chaput's method. Plan of suturing shown.

of coaptation and leaves the intestine straight. We are disposed to extend the application of the term enteroplasty, for the sake of convenience, at least, to the repair of serous surfaces of the intestines by means of omental
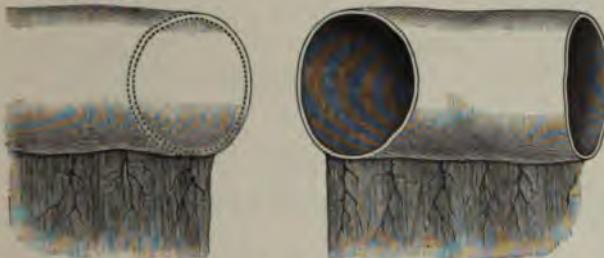
FIG. 1025.—Circular enterorrhaphy, oblique section, no elbowing.

grafting, and the transference of serous surfaces by sliding, jumping, etc., as may be required in connection with repair of a wounded, non-serous intestinal surface.

Omental Grafting was set forth by Senn, and is advised for the repair of all peritoneal defects, especially the union of serous surfaces by sewing. Omental grafting is practiced in the following manner: Grafts of proper size and shape to meet the indication are cut from the omentum and placed at once in the hot saline solution. Slight scarification for an inch or so at

FIG. 1026.—Omental graft, Senn's method.

both sides of the part to be repaired is quickly practiced; take the graft from the solution, place it between two layers of aseptic gauze to remove superfluous fluid, place it carefully in position over the serous defect and fix

it there with a few fine catgut sutures (Fig. 1026). In the course of a few hours the graft becomes quite firmly adherent. Omental grafting is advised for the repair of other peritoneal defects than those the result of sewing, to
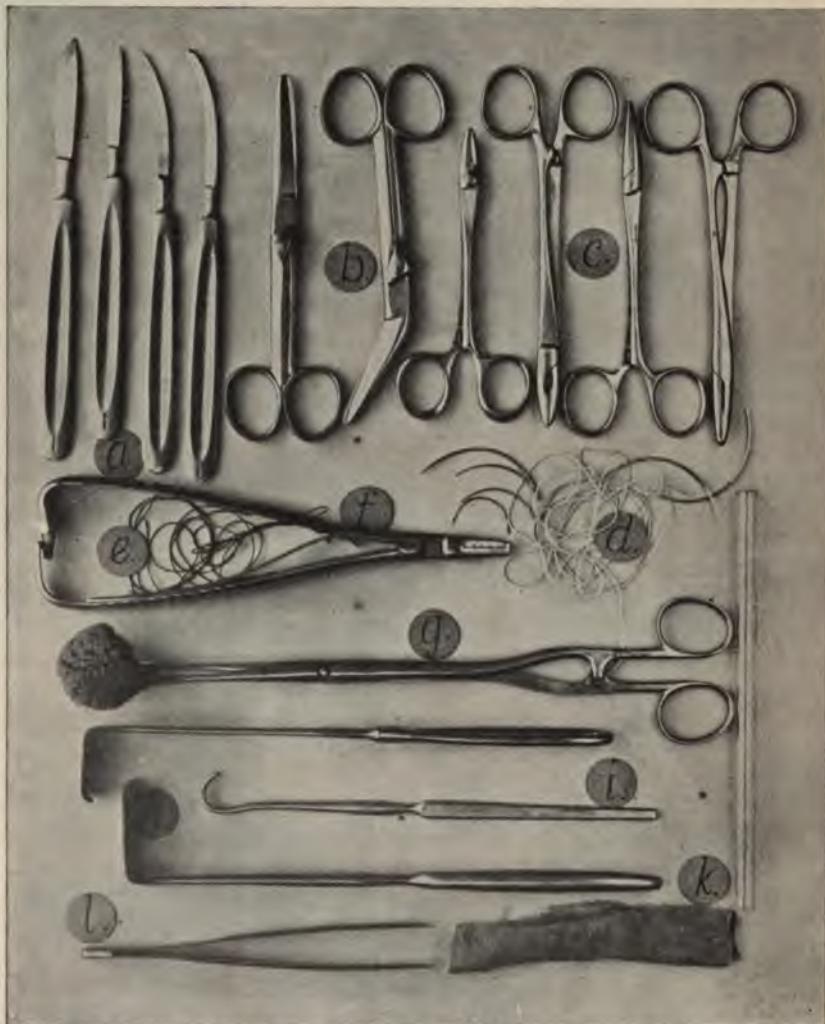
Fig. 1027.—Instruments employed in colostomy, etc.

a. Scalpels and bistouries. *b.* Scissors. *c.* Forcipressure. *d.* Needles and traction loops. *e.* Ligatures. *f.* Needle-holder. *g.* Sponge-holder. *h.* Blunt retractors. *i.* Blunt hook. *k.* Glass rod and iodoform gauze for support of intestine. *l.* Thumb forceps. Tenacula, mouse-tooth forceps, sponges, wipers, large rubber-tube trocar and cannula, small basin, rubber tissue, and an abundance of gauze, etc., should be provided.

obviate adhesion of injured serous surfaces. The objection is made to this kind of grafting that the grafts contract and interfere with the outline and caliber of the lumen of the intestine.

Colostomy.—The term colostomy is applied to the establishment of an artificial anus in the colon, but for the sake of simplicity it should include also the cæcum (cæcostomy) and sigmoid flexure (sigmoidostomy). The object of the operation is for the relief of obstruction of the large intestine, and to divert the fæcal current from contact with distal ulcerating on sinous surfaces. The author has once performed colostomy for the relief of otherwise inoperable prolapse of the rectum with marked palliative results. *There are two common varieties of colostomy*, inguinal and lumbar, the former being intraperitoneal and the latter usually extraperitoneal. Inguinal colostomy may relate to the cæcum (cæcostomy) or sigmoid flexure (sigmoidostomy) according to the side attacked. Lumbar colostomy is applicable to either side, but is commonly effected at the left (page 830).

Iliac Colostomy (Littré).—Formerly the lumbar incision was more commonly employed than the inguinal, but now the former is rarely done except in those cases in which malignant involvement or binding down of the sigmoid flexure makes it impracticable to open or reach the latter, and also in rare cases attended with great distention of the gut and other manifestations calling for prompt, imperative action, the better met by the latter plan. An artificial anus at the left iliac fossa is more conveniently situated, the steps of the operation are less perplexing, and the sequels less significant than in lumbar colostomy, except as to the danger of peritonitis, and even this is insignificant in the presence of modern aseptic methods. Moreover, the operation is easier for the surgeon and safer for the patient, so far as anæsthesia is concerned. A flaccid colon in a fleshy patient renders the lumbar operation exceedingly difficult. However, careless technique in the inguinal operation may cause fatal peritonitis and also annoying prolapse. At the outset the need of a temporary fistula or a permanent anus should be if possible determined.

The Operation.—Place the patient on the back with the limbs extended; make an incision two inches and a half in length with the center corresponding to the anterior superior spinous process of the ilium at a point an inch and a half inside this process (Fig. 1029) in the course of the fibers of the external oblique; separate and draw apart as for removal of the appendix (page 870) the fibers of the external oblique and in turn those of each succeeding muscle as soon as it appears, until the transversalis fascia is reached, which, along with the peritonæum, is divided for about two inches in the line of separation of the transversalis fibers; introduce a strong retraction suture through all of the tissues at each side of the wound, in order to draw the borders of the wound wide apart and prevent the stripping up of the peritonæum incident to manipulation; introduce the index finger into the abdominal cavity and carefully examine the contiguous parts for the presence of disease manifestations; withdraw the finger, bringing along with it a loop of the sigmoid flexure; make downward traction on the upper limb of the loop and thus pull the intestine from above, returning it as fast below, until the mesocolon prevents further escape; pull out the sigmoid loop sufficiently to expose the attachment of its mesentery; open the mesentery at the point of attachment near to the middle of the loop and thrust through the opening a sterilized glass (Fig. 1028) or rubber rod, or

roll of iodoform gauze, of sufficient length to rest readily at either side of the wound, on the surface of the abdomen; lift the intestine upward a little with the rod or gauze and unite the portions of the loop immediately above and below it with each other by two sutures passed at either side through the sero-muscular walls of the intestine and tied so as to form a proper spur (Fig. 1029); unite the protrusion to the borders of the abdominal open-

Fig. 1028.—Iliac colostomy, rod and sutures placed to form spur. *a.* Glass rod. *b.* Sero-muscular sutures. *c.* Skin. *d.* Fasciæ. *e.* Muscles. *f.* Fasciæ and peritonæum.

ing by interrupted silk sutures passed with a curved needle through only the musculo-peritoneal borders of the wound and the sero-musculo coats of the intestine respectively; cut the ends of the sutures long, treat the intestine with sterilized vaseline and the remaining portion of the wound with iodoform gauze. Cover the whole with aseptic gauze held in place by an ordinary binder. At the end of three days, union of the surfaces will have occurred, when, according to the demands of the case, one or two courses can be pursued, the establishment either of a permanent artificial anus or of a temporary fæcal fistula. *If an artificial anus be the desideratum* (see page 819 *et seq.*), seize the loop of intestine with mouse-toothed forceps, and with scissors remove the wall of the bowel to within half an inch of the line of suturing, arresting the bleeding points as they arise; divide the bowel through transversely in the line of the rod, permitting the lower segment to retract; remove the sutures first applied and stitch the end of the upper segment to the integumentary borders of the wound. *If only a temporary fæcal fistula is desired,* make a short, longitudinal incision at the convex surface of the loop, remove the primary sutures, and join the borders of the intestinal incision at three or four points with the integumentary borders of the wound. The rod is removed in a week or ten days and the sutures taken away. The bowel then falls downward into place, retraction obliterates the spur, and more or less of the fæcal flow resumes the natural channel, and thus it continues until cured by natural or artificial means.

The Remarks.—Instead of the glass rod or iodoform gauze to hold

Fig. 1029.—Iliac colostomy, bowel raised up and supported by a firm roll of iodoform gauze (Fig. 1101, *m*).

the intestine in place, the mesocolon can be sewed to the borders of the wound.

If the case is not urgent, the intestine when pulled well out of the wound can be transfixed with long, slim pins (Fig. 1062), inserted transversely

through the wall without penetration of the lumen, about three fourths of an inch apart, the extremities resting finally on iodoform gauze placed at either border of the wound. The margins of the wound are then carefully closed with chromicized-catgut or silkworm-gut sutures, and the walls of the bowel united at the same time to the cutaneous border of the wound with fine sutures of the same kind. The parts are covered with proper dressings, which after four or five days are renewed, and a crucial opening is made with a pointed bistoury between the pins. This method of practice divides the operation into two stages, thus lessening greatly the liability of local wound infection and its frequent and unfortunate sequels. After closure of the opening of the distal part of the bowel, *Paul* advises the introduction into the proximal part of a glass tube an inch in diameter (Fig. 1030), held in place by a purse-string suture, to which is connected a rubber tube to carry away the fæcal discharge. Later, the superfluous extremity of the bowel is cut off. The stitching of the parietal peritonæum to the integumentary border of the wound, to secure prompt union with the gut, is practiced infrequently now, because the repair is regarded less secure than that from the contact of the cut borders of the wound with the bowel. Nevertheless, if the bowel be fastened as directed, the prompter union may be secured without special danger of subsequent prolapse. If the sigmoid flexure evade detection, the introduction of

FIG. 1030.—Paul's tubes for use in colostomy. *a.* For large intestine. *b.* For small intestine.

water or air into the rectum, with the finger at the brim of the pelvis, will soon reveal the whereabouts of the bowel, and if it pass to the opposite side the site of the operation should be changed at once.

The Precautions.—The pulling down of as much of the sigmoid flexure as practicable before uniting it with the wound, limits the subsequent prolapse of mucous membrane. If, as sometimes happens, the presenting loop be twisted at this time, the direction of the line of traction will be reversed, with obvious results; a prolapsed transverse colon may be mistaken for the required flexure. The opening in the distal extremity of the divided gut should not be permitted to close when frequent cleansing of this portion of intestine is desirable, as in connection with inoperable malignant disease. In fact, the patency should be maintained in these cases by the introduction through the opening of a large rubber tube or a plug of gauze. If entrance of fæcal matter to the lower segment of the bowel be not prevented primarily by the inversion and closure of the borders of the opening (Senn), the influence of subsequent cicatrization may close it with or without the aid of supplementary procedure. Much has been said from time to time regarding the practice of dividing the bowel entirely, closing the lower end, and dropping into the peritoneal cavity. At the first blush this course seems practicable, since it at once prevents the entrance thereto of fæcal matter, but when it is recalled that a long, twisted mesentery may again—as often before—cause the upper to be mistaken for the lower part—unless the latter have been explored from below—that the lower may contain already

much fæcal matter; that division of the gut increases the difficulty of operation, and exposes to greater danger of infection; and, finally, that the formation of a pronounced spur will prevent fæcal flow into the distant part, which still remains patent for cleansing purposes, it will be seen little remains to be said in support of the practice in many instances.

The Sequels.—Fæcal incontinence should be treated with compresses, or even a hernial truss; excoriations, with vaseline, oxide of zinc, etc.; prolapse of mucous membrane, by excision and reunion to the borders of the wound.

The Results.—The rate of mortality from the operation alone is about two per cent.

Bodine's Method.—The steps of this commendable procedure need not differ in any essential regard from those of the preceding until after division of the peritonæum. The divided borders of this membrane are then stitched to those of the integument. A loop of intestine about twelve inches in
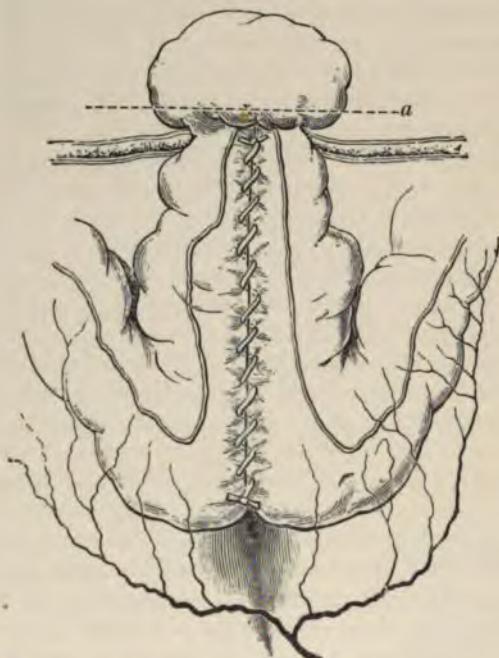
Fig. 1031.—Bodine's operation of colostomy by lateral approximation, with final restoration of the continuity of the canal. The sewing of one side of the loop is shown, with the bowel pushed back and ready for stitching to the abdominal wound. The lesion remains without, and the dotted line (*a*) indicates where it is to be cut off.

length is drawn out through the opening, and carefully protected with gauze; the surfaces of the intestine are properly apposed and held in place by two rows of continuous silk sutures, six inches in length, placed one inch apart, one row behind the other in front of the loop (Fig. 1031). The loop is then pressed back into the peritoneal cavity until the point at which the

opening is to be made is nearly on a level (*a*) with the integument, when, if the gut is to be opened at once, it is joined to the margin of the abdominal wound by a continuous silk suture; if not until twenty-four hours later, catgut may be used instead. Any important structural change of the wall of the intestine at this situation should be made to appear at the apex of the loop, and the intestinal surfaces are then so united for about six inches, that thereafter the morbid process can be removed, leaving the spur properly located. If the fistula is to be permanent the meseneric attachment may be located midway between the two rows of sutures.

If subsequent repair of the intestine be contemplated, the approximation sutures should be so placed that one row will be close to and parallel with the mesenteric attachment, and the deepest part of the approximation should be fortified by interrupted and continuous sutures to secure that part against all danger of leakage after division of the septum.

The cure of a fœcal fistula established by this method of practice is singularly simple, safe, and effective. For this purpose the septum is divided in the median line with Grant's enterotome (Fig. 1032), or with ordinary sharp, blunt-pointed scissors, carefully guided by the finger.

FIG. 1032.—Bodine's operation of colostomy showing division of the septum with Grant's enterotome in restoring the fæcal current. In permanent colostomy this septum remains as a rigid and effective spur.

The external opening is then closed in the usual manner. In dividing the septum care should be taken not to injure the mesenteric vessels lying near its border, nor to sever the lower limits of the approximation. In the instance of either a temporary or permanent fistula, delayed opening of the gut can be readily accomplished under localized cocain anæsthesia.

Cripps's Method.—The technique of Cripps's method differs from that of the preceding in some important respects. Cripps united the borders of the divided peritonæum with corresponding borders of the integument with several stitches (*b, b*), thus lining the opening with a serous surface. The intestine is drawn into the opening by means of traction sutures (*a, a*) passed through the anterior fibrous band of the intestine (Fig. 1033), and it is then sewn to the skin and peritonæum in such fashion that two thirds of the circumference of the bowel will present outside the sutures; the

sutures at the lower border are passed through the lower longitudinal band, and at the inner, through the muscular coats of the intestine near to the
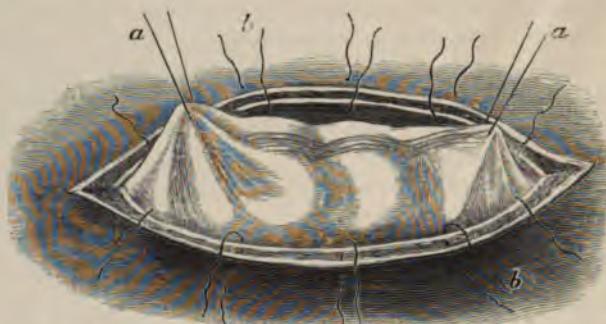
Fig. 1033.—Iliac colostomy, Cripps's method. *a, a.* Traction loop passed through fibrous band. *b, b.* Sero-cutaneous sutures.

mesenteric attachment (Fig. 1034). In the later cases Cripps made the incision higher, nearly on a level with the umbilicus, in order that the lower part of the abdominal wall, "where the pressure is the greatest," may be spared as much as possible; also, he made the incision into the abdomen as small as practicable for a similar reason, and to prevent prolapse.

The After-treatment.—The wound is dressed lightly with iodoform gauze, and is examined thereafter in twenty-four hours to note if proper
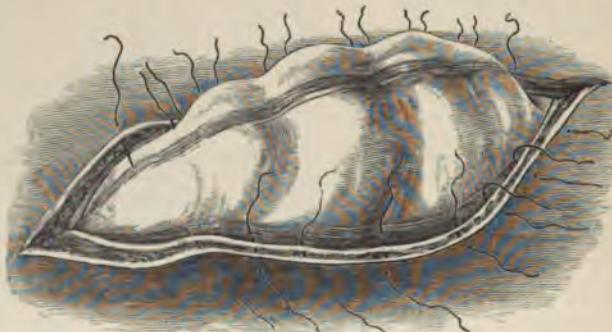
Fig. 1034.—Iliac colostomy, Cripps's method.   Intestine sutured in place.

union be maintained, and may not again be inspected until the time for opening the bowel has arrived.

Réclus's Method.—Réclus regards the preceding method as unnecessarily complicated, and advises the employment of local anæsthesia (cocain) and a short vertical incision (two-inch) located between the anterior superior spine and the umbilicus; also, pulling the colon (sigmoid) through the opening so as to expose the mesenteric attachment, and transfixing it and introducing the supporting rod out of line with the vessels, as low down as possible, to increase the prominence of the distal end of the gut.

Simple aseptic dressings are then applied, and at the end of the third day the bowel is opened by a short longitudinal incision. Any distention happening before this time can be relieved by the passage of a fine trocar obliquely into the gut. The supporting rod can be left in place for two weeks. The adhesion of the serous surface of the bowel to the tissues of the wall of the wound is regarded by Réclus as firmer than the union of serous surfaces with each other. *Hartmann* draws through a four-inch intermuscular dissection—the center an inch inside the spine—the sigmoid. He transfixes the mesentery with gauze, dresses the protrusion with it, and in forty-eight hours burns a small hole with a cautery through the *anterior* longitudinal band at the upper limit of the wound. The *results* are reported as excellent in all respects; no stitches are used.

Iliac Colostomy, right, should not be employed except as a temporary measure. The anatomical obstacles and the physiological objections to it are of a pronounced character. The absence or brevity of the mesocolon (page 830) making it dilffiuct sometimes to properly unite the colon with the wound, and the fluidity of the fæcal contents produce frequent, unexpected, and irritating movements, which cause debility and distress, each of which emphasizes strongly the unwisdom of the practice of this method. The technique of entry to the abdomen here is practised at a higher point, but in other respects is similar to that of the left side. When right iliac colostomy is performed a fistulous opening is desired, since it meets the demands of emergency and can be cured or soon supplanted by anastomosis of the ileum with the descending colon or sigmoid flexure.

If the abdominal incision be located comparatively as in left iliac colostomy, the cæcum will appear at the wound, and can be easily joined with the borders by sewing. Only a fæcal fistula can be established at this point. The physiological objections urged against opening the colon at the right side apply with a still greater force to opening the cæcum.

The Comments.—It may be necessary to open temporarily the cæcum to relieve the distention due to obstruction of the distal part of the bowel. If right colostomy be attempted and failure attends the cæcum may then be opened.

Colostomy of the transverse colon is rarely performed, and then only when the portion of the bowel beyond is unfitted for operation at the usual sites. The primary incision here corresponds to the location of the gut. The remaining technique is substantially like that of the sigmoidostomy (page 823).

Lumbar Colostomy, left (Amussat).—Left lumbar colostomy was formerly the accepted plan of entrance to the colon. But the beneficent influence of asepsis in the prevention of peritoneal inflammation, together with the facts that the posterior incision produced greater traumatism and exposed broader surfaces to infection, while it offered no good opportunity for intra-abdominal exploration, and placed the artificial opening inconveniently, prompted the substitution of the anterior for the posterior method in the majority of instances.

The Linear Guide to the Operation (Fig. 1035).—Draw a direct line between the anterior and posterior superior spinous processes of the ilium;

draw a second one perpendicular to this, one inch posterior to its center, to mark the line of the colon (*b*). Draw a third line with the center corresponding to the perpendicular one obliquely downward and outward four inches in length, parallel with the lower border of the last rib and midway between it and the crest of the ilium, to mark the course of the primary incision (*c*).

The Muscular Guides to the Operation.—The superficial muscular guide is the outer border of the erector spinæ muscle; the deep one the outer border and anterior surface of the quadratus lumborum muscle (Fig. 1036).

The Anatomical Points.—A mesocolon is present at this situation in thirty-six per cent of the cases (Treves). If it be not present, the posterior and a greater or lesser portion of the lateral surfaces of the colon are uncov-
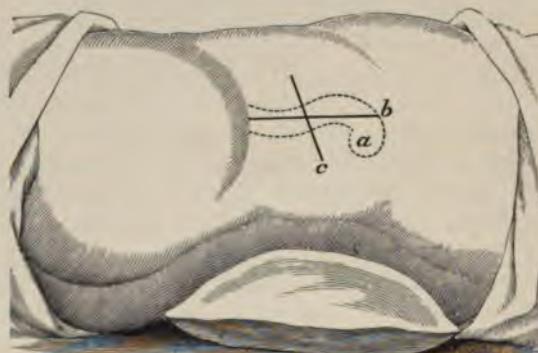
Fig. 1035.—Lumbar colostomy. *a.* Colon. *b.* Vertical line indicating colon. *c.* Line of incision in operation.

ered with peritonæum. If the gut be collapsed, it retreats toward the median line behind the quadratus lumborum, followed by the peritoneal covering, and therefore exposes the peritonæum to a greater danger of injury than when distended, since it then presses the peritonæum outward, and itself extends beyond the border of the quadratus lumborum. The intestinal surface not covered with peritonæum is hidden by subserous fatty tissue abundant in corpulent subjects. The colon is separated at this situation from the kidney, crus of the diaphragm, and anterior surface of the quadratus lumborum respectively by fatty tissue. The small intestines when present here extend to the outer side of the colon. The kidney is placed behind the colon, and its upper end can be easily determined if the finger be directed upward through the wound. The ilio-hypogastric and ilio-inguinal nerves pass obliquely outward in front of the quadratus lumborum muscle, along with the abdominal branches of the lumbar vessels.

The colon is recognized by its greenish color, scybalous contents, and its thin longitudinal bands: one anteriorly, one posteriorly at the point of attachment of the mesocolon when present, and one internally. Although the colon is not quiet during respiration, it does not move upward and downward, as the small intestines are sure to do at this time. Moreover, the colon is so fixed as to resist upward and downward traction to any extent.

while small intestines can be freely moved in every direction unless adhesion has taken place. Finally, inflation of the larger bowel with air will cause its distention as soon as relieved from its fatty environments.
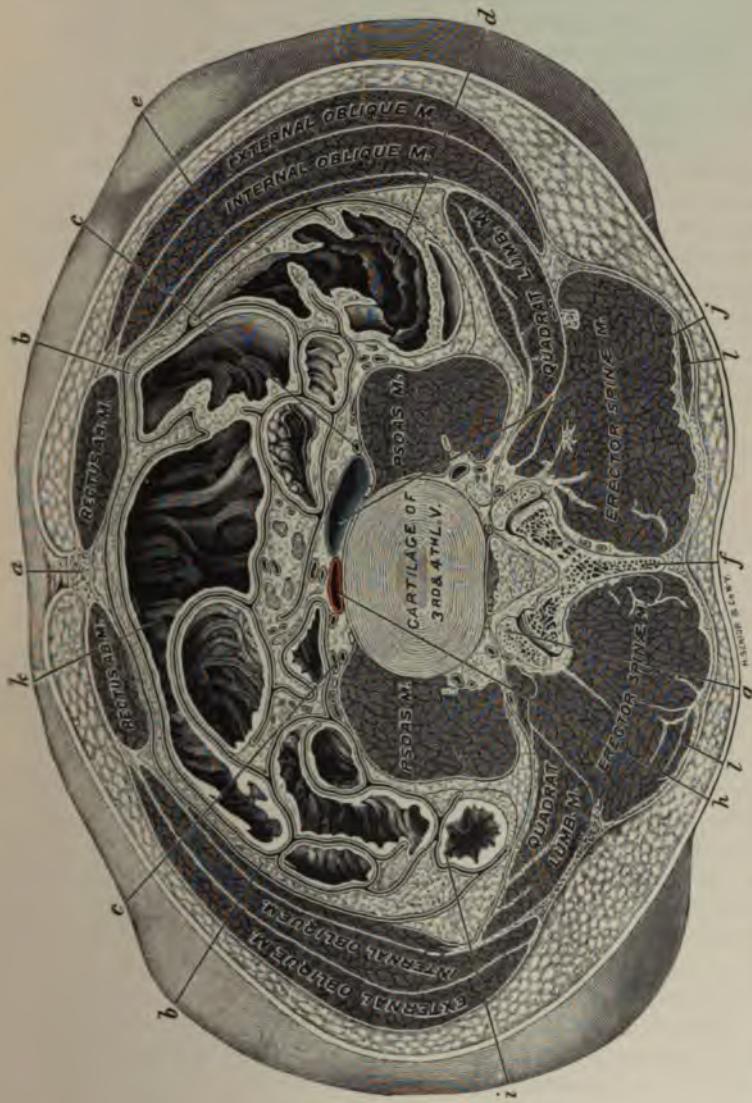
FIG. 1086.—Transverse section of abdomen. *a*, Umbilicus. *b, b*, Great omentum. *c, c*, Ureters. *d*, Ascending colon. *e, e*, Transversalis muscle. *f*, Spinous process of fourth l. v. *g*, Articular process of third l. v. *h*, Aorta. *i*, Descending colon. *j*, Vena cava. *k*, Small intestine. *l, l*, Latissimus dorsi.

The Fallacies.—The colon may be mistaken for a loop of small intestine, also for the kidney, especially in the young subject. It is easily distinguished from the former by the differences already stated; from the latter, by the greater density of the structure of the kidney, its rounded extremities, reniform shape, lobulated appearance, and the free movement of the

kidney with respiration. Distention of the bowel by gas will quickly indicate its individuality. The fat upon the transversalis fascia may be mistaken for the subserous fat, and consequently the transversalis fascia may be regarded as the peritonæum. At the right side the stomach has been mistaken for the colon; at the left the duodenum for the colon. The physical characteristics of the colon, and, finally, the prompt distention of it by insufflation, should quickly correct either of these misapprehensions. In the instance of a collapsed colon provided with a mesentery, the peritonæum may escape injury if the bowel be distended with air before it is opened, as then the entrance to it may be made between the mesenteric folds.

The colon may be misplaced or absent. If it can not be found at the left it should be sought for at the opposite side, and opened in two stages, if practicable. If not found at all, or discovered only at a point below the seat of obstruction, enterostomy should be practiced. A protrusion of peri-
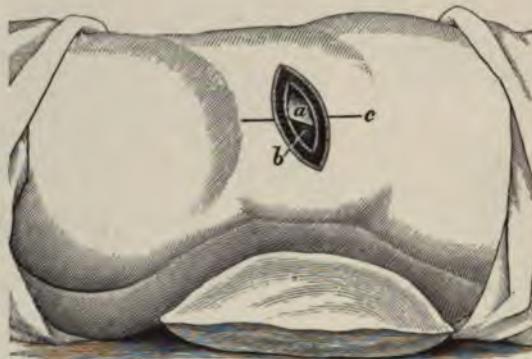
Fig. 1037.—Lumbar colostomy. *a.* Subserous fatty tissue. *b.* Quadratus lumborum muscle. *c.* Linear guide to colon.

tonæum into the wound, caused by ascites or dependent on a long mesocolon, often gives rise to much perplexity.

The Preparation of the Patient.—If admissible, thoroughly cleanse and disinfect the bowel. Place the patient on the sound side near the edge of the table, with the loin resting on a hard pillow or sand bag. Scrub and cleanse the field of operation and surround it with aseptic or antiseptic cloths in the usual manner. Ether is commonly employed for anæsthesia.

The Operation.—Make an incision three or four inches in length in the course of the oblique line (*c*) already marked out (Fig. 1035), carry it through the integument, fascia, and thick layer of fat usually found at this situation, down to and through the latissimus dorsi (1036, *l*) and the posterior fibers of the external and internal oblique and transversalis muscles in their order, and thus bring into view the outer border of the quadratus lumborum incased in its compartment of the lumbar aponeurosis which passes outward and is continuous with the transversalis muscle (Fig. 1036, *e*); carefully divide the aponeurosis, avoiding the twelfth dorsal nerve as it passes in front of the quadratus lumborum to gain the transversalis muscle.

Draw apart the borders of the aponeurosis, along with the borders of the incision, with broad retractors or deep retraction sutures carried through the entire thickness of the borders of the wound. The fatty tissue lying between the aponeurosis and the transversalis fascia is now exposed and pushed aside. Divide the transversalis fascia and bring into view the subserous fatty tissue (Fig. 1037, *a*); open and push this structure aside with the finger and handle of the scalpel, thereby uncovering the anterior surface of the sheath of the quadratus lumborum muscle, which can be seen lying behind it (Fig. 1037, *b*). In the great majority of instances the intestine will appear in the wound as soon as the subserous fat is displaced (Fig. 1038). If the gut does not appear at this time, insufflation of the bowel with air by means of an ordinary bellows will promptly produce the result, and it is then rolled outward with the fingers from beneath the quadratus muscle—cutting the outer border of the muscle if need be—so as to expose its inner aspect, which is recognized by the presence of the longitudinal band. The passage of the index finger through the subserous fat in front of the transversalis fascia at the anterior surface of the quadratus lumborum to the psoas muscle (Fig. 1036, *i*), and its withdrawal in a hooked manner with
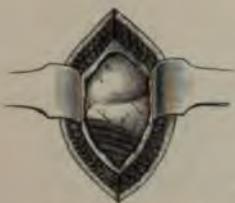
FIG. 1038.—Lumbar colostomy. Quadratus lumborum muscle below, fatty subserous tissue pushed aside, showing colon above.
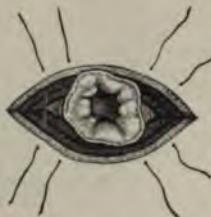
FIG. 1039.—Lumbar colostomy, showing colon opened and borders turned outward. Deep sutures laid for closure of extremities of wound.

the body of the patient rolled toward the left side, with or without pressure in front, will roll the bowel outward into view when other means have failed to expose it. In passing the finger inward for this purpose, the outer border of the kidney will be felt, and the finger should be passed in front of the kidney as the colon lies at this situation. Verify the identity of the colon by means of the numerous tests already given (page 830). Should the peritonæum have been opened, close the breach with catgut sutures if it can be done readily, otherwise, let it alone, as the withdrawal of the bowel will close the opening and no harm can follow if the operation field be aseptic. Draw the gut outward to the surface of the wound by means of forceps, aided with pressure in front if necessary, and while it is retained in this position close the extremities of the wound with silkworm-gut sutures that shall include the tissues of the borders down to the lumbar fascia (Fig. 1039). Tie these sutures, and then unite by sewing the surface of the bowel with the deep borders of the wound all around, the sutures passing through the muscular wall of the gut (Fig. 1021). *If the case is urgent*, smear the wound and surrounding surface freely with iodoform-

ized vaseline; place the patient on the back and open the gut longitudinally with a scalpel sufficiently to admit the extremity of Paul's tube (Fig. 1030), which is tied in place with a purse-string suture, thus permitting the contents to escape into the proper receptacle without soiling the wound. If to the end of Paul's tube a piece of rubber tubing be attached, the discharges will be carried still farther away. In fact, rubber tubing can be employed from the first for the purpose, by inserting and fastening one end into the intestine.   The amount and consistence of the intestinal contents will depend not a little on the previous treatment of the patient: constipated movements attending the administration of opium, and copious discharges the use of cathartics. When practicable the intestine is united to the borders of the wound of the abdomen before opening the gut (Fig. 1040), thus the better preventing infection of the wound.
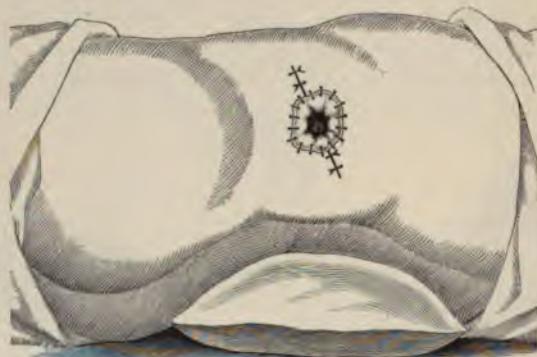
FIG. 1040.—Lumbar colostomy. Borders of colon wound united to integuments and subcutaneous tissue.

The Precautions.—Avoid mistaking the stomach at the left and the duodenum at the right for the colon. A displaced and hypertrophied loop of small intestine, or a prolapsed long mesocolon, may simulate the colon. If the wound be deep and the intestine be drawn taut when fastened to its borders the sutures should be supplemented with pin support to hold the gut securely in place. If scybalous matter be present at the opening it should not be disturbed unless necessary, and then with extreme caution, until firm union of the parts is established. The opening should be made as small as practicable to avoid subsequent prolapse of mucous membrane, and the diet of a kind to obviate constipation. The patient should lie upon the back, or toward the wounded side, until the union of the parts will safely withstand the traction of different postures.

The Remarks.—If the colon can not be found at the loin, it should be sought for through a median incision, and, if diseased, returned to the proper place and treated. Or, what is better, withdraw and open the sigmoid in front if practicable. If neither of these measures be advisable, the cæcum can be entered through the median incision, or one made at the side as already described. Enterostomy can be practiced if the other plans offer no relief, but with a dubious outcome. If fæcal matter enter the

distal segment of the intestine and cause trouble, it can be turned aside entirely by closure of the upper end of this part with mucous membrane displaced from the upper opening and fastened in place with sutures (Jones). The entire division of the gut should be avoided, since peritoneal infection is very liable to arise from this measure. Many other complications of this operation occur, that are foreign to iliac colostomy, and the large number of perplexing contingencies already stated only emphasize the greater utility of the iliac route of entry.

The After-Treatment of Colostomy.—The patient should remain in bed quiet, subsisting on a simple *regimen*, until the immediate dangers of the operation are gone and firm union of the parts is established. Measures to promote cleanliness and prevent irritation of the parts are of constant importance. The regulation of the diet to sustain the patient, keep the bowels soluble, and the discharges unirritating, are significant *desiderata*. When the wound is healed control of the opening is secured quite as well by simple pads fashioned by the patient to meet the needs which his experience suggests, as by those planned only on the basis of theory. As a too small opening means fæcal dribbling, the opening should be maintained at proper size by dilatation with the finger, laminaria, or by special apparatus.

The Results.—The rate of mortality is variously estimated from 20 to 38 per cent. Somewhat recently (1884) Dr. Batt reported 244 cases with a death-rate of a little more than 31½ per cent. However, these figures can not be regarded as indicating the results of more advanced thought and method. The later reported experiences of Cripps and others are far in advance of those reported by Batt.

Right Lumbar Colostomy.—Lumbar colostomy at the right side is indeed rarely performed, and then as an emergency measure. The objections to the anterior opening at the right side (page 829) apply with equal force to the posterior one at the same side. The colon is associated more directly with the abdominal wall at this than at the left side, as a mesocolon at the right side is ten per cent less frequent than that at the left (Fig. 1036). The technique of the operation is similar to that of the left in all the stages, but the results are less propitious at the right, for easily understood physiological reasons.

The Prognosis in Intestinal Obstruction.—*The fatal results attending operations for intestinal obstruction are truly frightful, and are caused much more by meddlesome medication yoked to complacency and procrastination, so often seen in these cases, than to all other influences. The persistent administration of cathartics and alimentation by the mouth fills prematurely to overflow the proximal segment of the obstructed intestine. Finally, purposeless delay, associated with ever-increasing accumulation, and infection causes great intestinal distention and paralysis, thus introducing new elements of danger to the patient of greater moment than the obstruction itself.* As can be easily conjectured, the varied conditions of the patients represent every phase of involvement from the inception to final collapse, when the surgeon is called. It follows, therefore, that different methods of attainment of the object must be practiced in order to prolong, if not to save, the patient's life. In the majority of cases an operative pro-

cedure based on complete scientific technique can not be practiced at the outset without imminent danger to the patient.

In the very urgent cases the object should be to relieve the overdistended bowel at once, and thus bridge the chasm between an inevitable disaster and a hopeful outcome.

The Treatment in these Cases.—Before operation wrap the patient in hot blankets. Surround him with bottles of hot water; give hypodermatic injections of brandy, strychnine, etc. Under cocain anæsthesia perform enterostomy at the right, low down or at the median line below the umbilicus, while many of the preceding expedients are being carried into effect; introduce the finger and pull out a loop of intestine; hold it in place with the finger or fix it in the wound with sutures, as time will allow; open it longitudinally with a scalpel or evacuate it with a small trocar with a rubber tube attached, being careful in either case to prevent fæcal escape into the abdominal cavity. Administer hot, stimulating, and nutrient enemata, and wash out the stomach with hot water as soon as practicable. Put the patient in bed surrounded with hot blankets or bottles of hot water, followed by a hot saline enema.

In the less urgent cases aseptic technique and general surgical preparation for operation can be made. In these cases the stomach should be washed out thoroughly before operation, especially if fæcal vomiting have occurred. Anæsthesia is utilized with care, and may be promptly supplemented with a small hypodermatic injection of morphin. Usually in these cases the author employs chloroform, since it is more agreeable, of quicker action, and less liable to cause vomiting. The incision is made in the median line and as near as possible to the seat of the obstruction, and large enough to admit the hand freely. Two strong retraction sutures are passed one through each side of the wound including the peritonæum; each is then looped and given in charge of assistants. The borders of the wound are separated widely by traction on the sutures, the omentum pushed aside, and careful examination is made for collapsed intestine before introduction of the hand. If collapsed and distended intestine be noted lying in contact with each other, the seat of the obstruction is located somewhere in the line of contact of these differently conditioned portions of bowel, and probably at the right of the patient if due to bands, for there Meckel's diverticulum and the mischief-making vermiform appendix are found. It is the practice of the author to push upward the distended intestines carefully as a whole by the aid of broad, thin sponges or large wipers, through an incision admitting of this procedure, till the collapsed ones appear; then, while the former are held upward, follow up the latter to the point of obstruction. By this course the seat of obstruction has been promptly located, and the temptation to eventration has not been experienced. In some instances partial removal and wrapping of the intestines in hot aseptic cloths was practiced on account of their extreme distention. If the jejunum alone be distended, the empty ileum will be overridden and pushed into the pelvic cavity, and for these reasons the abdominal distention will not be so great, especially at the lower part. The degree and location of abdominal distention will be measured quite definitely by the extent of the involvement of

the respective parts of the small intestine. *The condition of the cæcum is the key to the solution of the general seat of obstruction,* for, if it be not distended, the seat of hindrance is in the small, and if distended, in the large intestine. Therefore, the prompt ascertainment of the state of the cæcum is a matter of considerable weight, since the attention is then quickly directed to the portion of intestine involved and unnecessary handling of the structures and delay are avoided. The state of the vermiform appendix can be noted at the same time. The ordinary seats of hernial protrusions and the rare places of strangulation, as the diaphragm, the transverse mesocolon, foramen of Winslow (Fig. 1132), etc., should not be overlooked in the course of examination. In cases of extreme distention, partial eventration is a wiser and prompter procedure than the forcible introduction of the hand, attended with the danger of serous membrane rupture and quite certain failure of finding the point of obstruction. In fact, the best interests of the great majority of this class of cases will be better served by enterostomy and subsequent repair than by any other plan of procedure (page 817). Cases of obstruction must be treated according to the individual demands of each. In one, perhaps, the tedious process of unraveling and returning of the intestine loop by loop may be practiced in the search for the impediment, with the risk of going in the wrong direction. If the mesentery be straightened, the direction of its attachment to the posterior wall of the abdomen will suggest the course of the intestines. Irrespective of the plan pursued to find the hindrance, the latter should be removed as soon as found, and the intestines returned and the wound closed. Distended intestines attended with obstruction and paralysis should be evacuated through one or more small openings made with a scalpel at different situations (enterotomy), which are then promptly closed by sewing. The method of return of the intestine has already been described (page 812), along with the additional technique of treatment. In no instance should abdominal distention be present during or immediately after the closure of the abdominal wound. If overdistention prevent the locating of the seat of the obstruction, or the return of the intestines to the belly, free incision of one or more of the distended loops, and emptying out of their contents, will meet not only the preceding requirements but also prevent the evil influences of vigorous handling of the intestines and of autosepsis, likewise the disturbances of thoracic functions, so commonly associated with abdominal distention. *Greig Smith* advised that, in suitable cases, after the removal of the obstruction the distended intestines be emptied by the withdrawal of a loop and patiently utilizing, through a good-sized needle thrust into the bowel, the force of aspiration. By this plan the fluid and gaseous contents can be withdrawn in about half an hour, provided the suction be aided by gentle manipulation and contraction of the walls of the bowel. He believed that the leaving of a loop near the incompletely closed opening of the abdomen, for subsequent operation if needed, to be better practice than uniting the intestine to the walls.

The Removal of the Cause of Obstruction.—The general technique employed in the removal of the various causes of intestinal obstruction is essentially the same for all cases. The only changes in both general and special

methods of action relate to the operative requirements of the different obstructive conditions and to the devious complications that often appear in these cases.

Intussusception.—In intussuception an upper portion of the intestine is invaginated into the lower; the reverse is seldom noted. Invaginations are usually single (Figs. 1041 and 1043), may be double (Fig. 1042), and sometimes of a triple character. The outer part or sheath is denominated the *intussuscipiens*, the inner or invaginated part the *intussusceptum*. Enteric invaginations happen in 30 per cent, colic, including the rectal, 18 per cent, ileo-cæcal 44 per cent, and ileo-colic 8 per cent of the cases. Intussusception is a prolific cause of intestinal obstruction at all ages (30 per cent), especially before eleven years of age, when it reaches 53 per cent. Only about half (48 per cent) of the cases are acute, the remainder are subacute (34 per cent) and chronic (18 per cent). The seat of the intussusception is at the ileo-cæcal region in 45 per cent, in the colon in 18 per cent, and the small intestine in about 12 per cent of the cases. The prognosis is very grave at the best, since 70 per cent terminate fatally, and three fourths of these succumb within seven days of the attack (Treves). Two methods of treatment are advised: 1, disinvagination by distention of the bowel with gas or fluid, aided by anæsthesia and manipulation; 2, abdominal section with either (*a*) manipulative disinvagination; (*b*) intestinal anastomosis; (*c*)

Fig. 1041.—Single intussusception, vertical section. *a*. The apex. *b, b*. The neck. *c, c*. The entering layers. *d, d*. The returning layers. *c* and *d*. The intussusceptum. *e, e*. The intussuscipiens. *f, f*. The peritonæum. *g, g*. The muscular coat of intestine. *h, h*. Mucous membrane of intestine.

artificial anus, with or without resection; or (*d*) resection of the intussusception and enterorrhaphy.

The distention of the intestine by either of the preceding methods after two or three days' duration of the invagination, or in the presence of acute symptoms of even a lesser period, offers but little encouragement, indeed, of a favorable outcome, and when practiced the effort is made tentatively and briefly rather than with the assurance and effort often permissible at an earlier period. In either method the patient should be anæsthetized and the distending force slowly exercised through the medium of a rubber tube passed well up into the bowel, and held there by pressure against the buttocks, so as to prevent the escape of the distending agent along the course of the tube. Air and gas can be forced by the ileo-cæcal valve, and are therefore useful in intussusception of the small intestines as well as the large. Water (saline solution), however, can not be forced by the valve with safety to the patient, and consequently is useful only in invagination involving the large intestine. The manipulation of the "sausage-shaped" tumor indicating the seat of invagination is of questionable utility, and
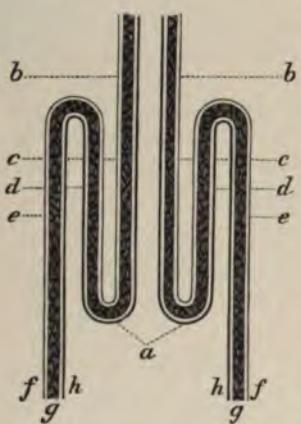
should be carefully practiced by rolling the tumor from side to side, gently squeezing it, pressing backward at either end while the tumor is held as gently as possible with the hand. At all events, whatever is done in this regard should be done gently, and be relinquished promptly after trial.

The Distention with Air.—In this instance the rubber tube is connected with a bellows which is slowly worked, while the procedure is attended with a careful inspection of the abdomen to determine the seat of obstruction by noting the line of ascending distention if it be not obscured already by obstruction tympanitis.

The Distention with Carbonic-acid Gas.—For this purpose 3 drachms of bicarbonate of soda and $4\frac{1}{2}$ drachms of tartaric acid are dissolved separately in water, and portions of either solution are passed alternately into the tube at intervals of six or seven minutes (Ziemssen). These solutions are employed thus slowly to obviate any danger of overdistention incident to a too rapid generation of the gas. The phenomena incident to this method of distention are scrutinized with the same care as in the preceding instance.

FIG. 1042.—Double intussusception. *a.* The upper invaginated portion. *b.* The lower portion of the bowel.

The Distention with Hydrogen Gas.—An ordinary rubber balloon with a capacity of from two to four gallons is the simplest, safest, and most efficient instrument for making rectal insufflation (Senn). The balloon is connected by a metal tube to a rubber one, and the gas is slowly discharged through the latter into the bowel by compression of the bag with the hands.
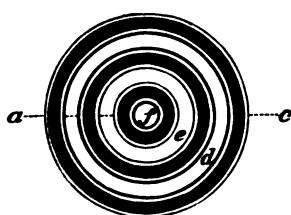
FIG. 1043.—Single intussusception, transverse section. *a.* The entering layer of intussusceptum. *e.* Space between entering and returning layers of intussusceptum. */.* Lumen of entering segment. *d.* Space between returning layer of intussusceptum and inner surface of intussuscipiens. *c.* The intussuscipiens.

The balloon is a better agent by far for the introduction of air than the bellows or any mechanism of a less deliberate action. The gas should be discharged slowly through a stopcock easily regulated and of a caliber not larger than a line or two in diameter at the point of exit. During the introduction of the gas the patient should lie on the back to afford the surgeon the opportunity to outline the course of distention, and especially to recognize the passage of gas through the ileo-cæcal opening, which is indicated by a gurgling sound that not infrequently can be heard several feet away from the patient. A sudden lessening of the pressure in the use of either agent indicates that disinvagination has taken place, or that rupture of the intestine has happened. If the latter have occurred the escape of gas from the intestine into the perito-

neal cavity, together with the additional amount slowly introduced through the tube under low pressure, will cause a general tympanitis with loss of liver dullness; increasing dullness on percussion indicates the escape of fluid; while in disinvagination decreased pressure is followed by continued upward intestinal distention in a regular manner, and the presence of liver dullness.

The Distention with Fluid.—As before remarked, the benefit of liquid distention is limited to involvement of the colon. The common method of practice is to pour the fluid into a funnel held about three feet above the patient and connected directly with the outer end of the intestinal tube. The fountain syringe can be employed instead. The patient need not be inverted during the administration. The capacity of the colon in the adult is from a gallon to a gallon and a third. In the infant from ten to twenty ounces. The introduction of the fluid should be done slowly, with the head placed low and the pelvis raised. Sometimes this plan is practiced without the use of an anæsthetic. Lukewarm saline solution is commonly employed, but warm oil can be used instead.

The Remarks.—Prolonged distention with low pressure is more service-able and less risky than rapid distention with high pressure. It is impos-sible to estimate definitely the amount of fluid and the degree of pressure that will cure or can be safely borne in all cases. If rupture happens, abdominal section must be done at once. Strong objections are made against the use of any distending agent by some, because of the uncertainty and delay of relief, the danger of rupture, the deceptive results, and the fickleness of cure.

The Results.—The employment of either of the preceding measures, before adhesion shall have taken place between the invaginated portions, is commendable. The earlier the use, the safer and the more favorable is the outcome. After two or three days have elapsed, the prospect of benefit and the danger of the attempt are inversely proportioned. The employ-ment of gas or air offers the best means of treatment with a minimum danger of use, provided proper care be exercised in the administration. And, too, their influence is more extended than that of fluids, as the effect of the latter is limited to the large intestine alone. Still, the circumstances attending the case often require the utilization of fluids as the simpler and more available means of treatment. In 72 cases of all degrees of severity reported by Wiggin, intestinal distention failed in 54 instances. *Barker* reported 42 cases, 11 of which were treated by injection only, with 9 recov-eries; 16 cases in which injection failed were treated by abdominal section, with 8 recoveries; 15 cases by abdominal section only with 7 recoveries. In 50 cases treated by distention, the average time from the onset of the ob-struction is three hours and a half in the successful cases and about forty hours in the unsuccessful.

Abdominal section (page 739 *et seq.*) should follow promptly in these cases after failure of the preceding means of treatment with the view of securing relief by other and more active measures. The age of the patient is no bar to the attempt, for all ages have been rescued by the measures which at this time offer the main hope of relief. It is proper to say, how-ever, that the successful issue will depend largely on the promptness of the performance, and the knowledge and the ability to carry into effect the requisite surgical technique.

The Reduction by Manipulation.—For this purpose the abdominal inci-sion should be made near the median line as close as practicable to the site of the tumor, and long enough to permit of prompt and effective handling

of the invaginated part.   After exposure of the seat of the intussusception and its careful isolation with hot, moist, aseptic surroundings while within or after withdrawal (the latter preferable) from the abdominal cavity, a cautiously directed effort at restitution by manipulation is made by grasping the tumor between the hands and carefully yet firmly squeezing it from the base to the neck, so as to reduce the size of the œdematous intussusceptum, thus enabling restitution to follow gentle traction at the neck made in the long axis of this part of the tumor (Fig. 1044).   If adhesions be present between the serous surfaces of the invagination, it is advised by some surgeons that they be broken up by a blunt probe or the end of the finger.   As the constricted neck of the tumor will hardly admit the end of the finger without causing rupture of the gut, and as the presence of adhesions so strong as to require mechanical severance bespeaks impossible reduction, these bits of advice should be accepted with reluctance and be applied with apprehension (Figs. 1045, 1044).   *Hutchinson* advised that the intussuscipiens be drawn downward instead of pulling the intussusceptum upward, as is so often recommended.   At all events, careful traction in both directions should be practiced after the reduction of the œdematous swelling by squeezing, never forgetting that a too vigorous or prolonged effort at reduction greatly compromises the integrity of the gut and depresses the vitality of the patient, who is thus

Fig. 1044.—Single intussusception, longitudinal section.   Showing the relations of the important parts of the intussusception.

perhaps robbed of the benefits of other expedients in case of a failure of this.   After restitution of the intestine to its normal relations it should be examined carefully to detect any evidences of injury or points of uncertain vitality that may be present and require surgical attention.   It may be wiser in some instances to isolate the parts of the intestine of questionable vitality with iodoform gauze, and leave them outside of the abdomen, or inside even, pending Nature's solution of the doubt, rather than to sacrifice unduly the injured portion, or the patient's

opportunity of recovery, by attempts at immediate repair. When the integrity of the gut is assured, any accumulation of fæces or gases collected in the proximal portion of the intestine should be caused to pass along the disinvaginated part to a healthier portion before closure of the abdomen, in order that any obstruction at the impaired part of the intestine may be obviated until the function of the bowel is restored. A failure to reduce the intussusception calls prompt attention to the advisability of the adoption of other measures.
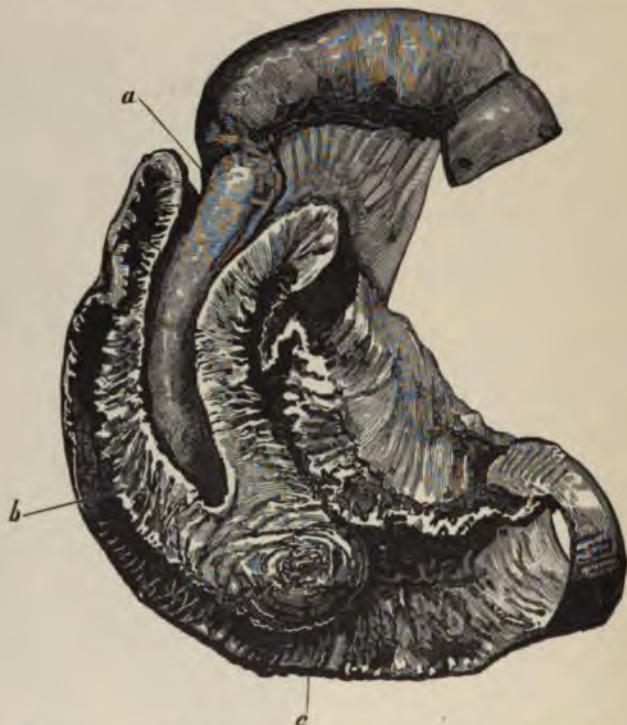
FIG. 1045.—Intussusception of the jejunum.   *a*. Internal cylinder.   *b*. Middle cylinder *c*. External cylinder.

The Remarks.—In rare instances reduction is accomplished easier at a later than at an earlier period. The tumor should be straightened as much as possible before reduction is attempted. Squeezing the intussuscipiens at the apex of the tumor is serviceable. Traction on the intussusceptum should be avoided in severe cases. Circumscribed thickening of the gut and thickening of the ileo-cæcal valve may be mistaken for incomplete reduction, requiring incision to make the distinction. Small doses of opium should be given for a few days to quiet peristalsis and relieve pain after reduction.

Lateral Anastomosis.—If the intussusception be a small one, and the involved intestinal structures be of undoubted vitality, and the condition of the patient admonishes the employment of a brief and expedient measure,

one loop of intestine is selected at the proximal and another at the distal aspect of the obstruction, the surfaces of which are brought in contact with each other longitudinally and without tension, and joined together in an expeditious and serviceable manner. Which measure should be adopted for the purpose is largely a matter of technical expediency, which can be decided by the surgeon himself at the time of the operation. The portion of the intestine excluded from the direct channel of fæcal flow by the operation appears thus far to invite no unfavorable outcome, but remains both inactive and innocuous to a satisfactory degree.

The Establishment of an Artificial Anus.—Artificial anus may be established with or without resection of the invagination. In the former instance it will likely take the place of a completer technique (enterorrhaphy) owing to the inability to properly conclude the operation as at first intended. Resection is not permissible in the presence of extensive invagination or great prostration. The establishment of an artificial anus *without* resection is applicable to those cases in which a fatal outcome would soon follow a more deliberate procedure. The method of performance is described under the head of enterostomy (page 817 *et seq.*).

The Remarks.—Regarding the last two preceding methods, but little can be said in their favor, as the former leaves behind a gangrenous intussusceptum and is almost always fatal. The latter plan is no less grave than the former. Either may prolong life, but neither is at all likely to effect a cure.

Resection with Enterorrhaphy.—The resection of the involved segment, and the union of the divided ends of the intestine by sewing or by the circular button of Murphy, has a limited application, and is not advisable in the presence of a knowledge of the more rational plans of Maunsell, Barker, or Paul.

The Remarks.—The results of resection of the obstruction and union of the divided ends by any method are of the gravest character, being almost uniformly fatal. A patient able to bear this operation is quite likely to be rescued by either of the following methods. However, if the intussuscipiens be gangrenous, resection must be practiced, and end to end union on lateral implantation or anastomosis of the small intestine to a healthy part of the colon done, followed by closure and return or by temporary fixation in the wound of the remaining open end.

Maunsell (Fig. 1046) advised that a longitudinal incision (*c, c*) be made through the intussuscipiens (1) down upon the intussusceptum, and that the latter be drawn through this opening sufficiently to bring the apex (*a, a*) and neck (*b, b*) of the invagination well into view, and then held firmly in place while the neck is divided transversely across (*a, a*, 2) and the open ends are sewed (*b, b*, 2) in the manner already described (page 760). The part is then disinvaginated by gentle traction, the longitudinal opening closed, and a few additional sutures are applied at the neck to strengthen the union.

Barker's Method.—*Barker's,* like Maunsell's method, comprehends the excision of the intussusception and its removal through an incision made at the convex surface of the intussuscipiens.

The opposed serous surfaces of the entering and receiving portions at the neck of the invagination are united together by a continuous suture of fine silk, carried so as to include the sero-muscular coats of both portions.
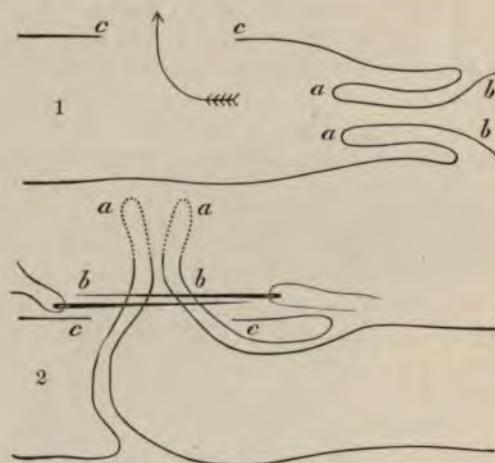
FIG. 1046.—The treatment of intussusception, Maunsell's method. 1. *a, a.* Apex of intussusceptum. *b, b.* Neck of intussusceptum. *c, c.* Longitudinal incision through intussuscipiens. 2. *a, a.* Point of division of neck (dotted line). *b, b.* Sewing of neck. *c, c.* Intussuscipiens.

A longitudinal incision is then made at the convex border of the intussuscipiens down upon the intussusceptum (Fig. 1047, *c*) of sufficient length to permit the ready removal through it of the latter body, which is then amputated as near as possible to the upper end (Fig. 1047). Stout silk ligatures are passed through the walls of the stump (*b*) and tied firmly,
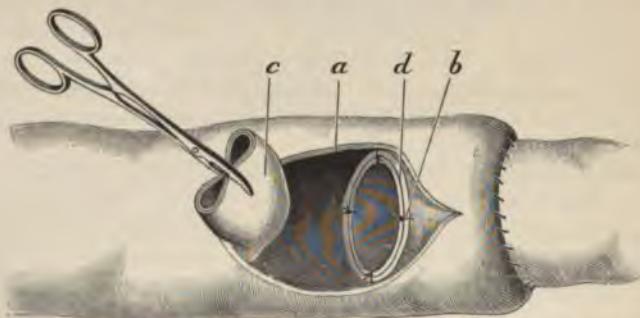
FIG. 1047.—The treatment of intussusception, Barker's method. *a.* Intussuscipiens. *b.* Sutures. *d.* The divided border of the intussusceptum. *c.* Divided segment of intussusceptum.

to keep the serous surfaces in contact and control the bleeding points. Usually four to six sutures are employed, the introduction being so timed as to keer   ~ith cutting away of the intussusceptum. The last suture con-

trols the circulation in the stump of the mesentery, which is not divided until after the suture is tied. The part is then cleansed, dried, dusted with iodoform, dropped into the lumen, the longitudinal incision closed as in Fig. 931, *b*, and the borders of the abdomen are united as in other instances.

The Precautions.—It should be noted whether or not the lumen of the intussusceptum is clear before the longitudinal opening is closed. If it be
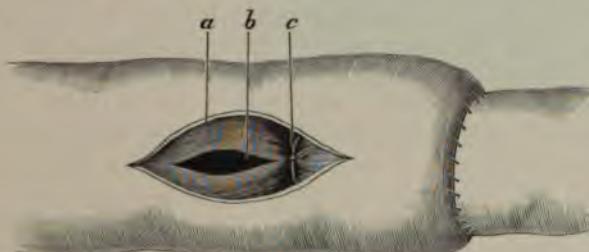
Fig. 1048.—The treatment of intussusception, Paul's method. *a.* Longitudinal opening in intussuscipiens. *b.* Longitudinal opening in intussusceptum. *c.* Ligature thrown around intussusceptum and spool.

impossible to remove the intussusceptum after section, it may be loosened and permitted to come away with the stools. If the stability of the technique be uncertain or the possibility of gangrene be suspected, a gauze drain should be introduced from without and be permitted to remain until the danger is passed.

Paul's modification of Barker's method can be more quickly performed, because a spool and ligature are substituted for sewing in the removal of the intussusceptum. However, the plan is not practicable when, as sometimes happens, the lumen of the intussusceptum will not receive the spool.
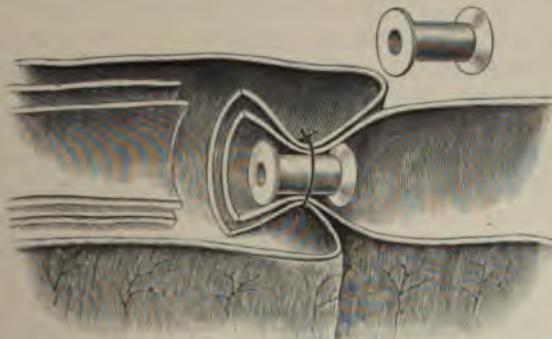
Fig. 1049.—The treatment of intussusception, Paul's method. Longitudinal section showing metal spool in position.

The serous surfaces at the neck are united with sutures; a longitudinal incision through the intussuscipiens is made, as in Barker's operation (Fig. 1047). A longitudinal incision is then made into the lumen of the intussusceptum of sufficient length to admit the metal spool, which is carried

into place and held by a strong suture passed around the intussusceptum where it grasps the spool, and tied (Fig. 1049). The intussusceptum is cut away, the longitudinal opening in the intussuscipiens closed, the parts are returned, and the abdominal wound is closed. This modification seems to present the alternative between quicker practice and the danger of prompter and more decided intestinal contraction.

Irreducible invaginations of the small into the large intestine can be treated in various ways as circumstances will permit: An artificial anus can be established at the lowermost part of the small intestine, the distal portion of which should be sewed firmly to the abdominal wall, and even clamped with forceps, to oppose any further invagination. The employment of Maunsell's or Barker's method of treatment may be thought proper in some of these cases, even though the intussusceptum can not be entirely withdrawn, for if divided it may promptly escape.

Baracz successfully treated a case of irreducible ileo-cæcal invagination by isolation of the tumor (Fig. 1050), and repair, by lateral anastomosis of the closed end of the ileum with the colon, above the point of occlusion (Fig. 1051). Sometimes ill effects follow the retention in place of the occluded portion of the intestinal tract.
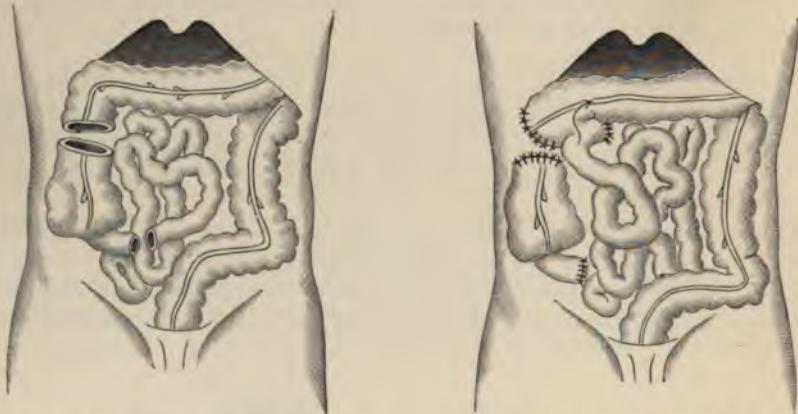
FIG. 1050.—The treatment of ileo-cæcal intussusception, Baracz's method. Isolation of the tumor. The ileum can be anastomosed with sigmoid (page 851, paragraph 2).

FIG. 1051.—The treatment of ileo-cæcal intussusception, Baracz's method. Isolation of the tumor and closure of the divided extremities. Enterocolic anastomosis.

Prolapsed invaginations are treated better by the plan of Mikulicz than by the older methods (*vide* Figs. 1041 and 1044). *Mikulicz* pulled down the intussusceptum (*a*) until its upper limit appeared, then made an incision transversely across its anterior surface, going carefully down to the peritoneal covering of the returning layer (*d*), then through it into the peritoneal cavity, arresting hæmorrhage as it occurred. The adjoining peritoneal [illegible] of the two layers (entering and returning) of the intussus- [illegible], *d*) were united together at the point of severance with a row

of fine silk Lembert sutures. After a similar treatment of the posterior half of the surface, the intussusceptum was removed and the remaining coats of the inner (entering) layer of the invagination (c) were joined with corresponding ones of the middle (returning) layer (d) previously divided. This method not only shuts off the peritoneal cavity above the point of constriction, but also unites firmly the respective layers of the intestine with each other, thus preventing infection of the raw surfaces and the consequent danger of non-union and peritoneal inflammation. In a time of emergency in this class of cases a stiff tube may be passed through the intussusceptum, around which the gut is ligatured at the upper limit with a strong rubber cloth, causing it to slough away as the serous adhesions take place.

The Results of Cœliotomy for Acute Intussusception.—" Out of sixty-five cases in which the intussusception could be reduced, thirty-eight died, a mortality of fifty-eight per cent. Among the children of this group, the mortality was sixty-six, among the adults forty-seven per cent. Of seventeen cases in which the affected bowel was resected and sutured, only two recovered, both adults. Of sixteen cases in which an artificial anus was made (with or without reduction or resection of the intussusception), two cases recovered, also both adults " (Curtis). Prolonged and delayed operations are nearly always fatal. The danger of relapse after reduction of the invagination ought not to be overlooked. To prevent relapse, Senn advises the making of a fold in the mesentery parallel with the long axis of the bowel, and sewing it in position with silk sutures, carefully avoiding any impairment of the circulation of the intestine. The need for this step is not generally recognized.

Volvulus.—Volvulus consists in the twisting of a loop of intestine on its axis so as to obstruct its lumen and vascular supply. It happens more frequently at the lower part of the ileum and at the sigmoid flexure, because at these parts the mesentery is the longest. The sigmoid flexure is involved in about a half, and the ileum a third of all the cases. Volvulus occurs about four times as often in the male as in the female, and usually between forty and sixty years of age in both sexes. Attempts are often made to untwist the intestine by external manipulation. However, the delay in diagnosis and the uncertainty of the direction of the twist, makes the attempt dangerous and success impossible at the outset. Abdominal section offers the only rational means of treatment of this obstruction.

The Operation.—Make an incision in the median line large enough to admit the hand; draw apart the borders of the wound by means of traction sutures passed through all of the tissues of either border; push aside the omentum and examine the field for distended intestine, which is usually seen at once; draw out of the wound the distended portion and examine for the seat and direction of the twist. If found, it should be untwisted if possible. If much distended, the contents of the loop and of the intestine above should be evacuated through a short longitudinal slit made at the convex border of the untwisted gut with a scalpel. The intestine is then washed out with sterilized water, the opening closed, and the intestine returned. If the loop first withdrawn offers no solution as to the seat of

the twist, additional loops are removed in their order and evacuated, if need be, until the seat of the obstruction is felt or brought in sight. Whenever a distended loop interferes with the untwisting, the evacuation of the contents facilitates the manipulation, saves time, and lessens the danger of injury to the gut. If it be impossible to unwind the pedicle on account of adhesions, after the volvulus is evacuated, either of the following methods can be practiced:

1. Lateral anastomosis of the proximal and distal parts of the intestine as near to the seat of the obstruction as practicable, thus removing the obstructed loop from the line of fæcal flow (Fig. 964).

2. Resection of the loop and union of the intestinal extremities by the end-to-end or lateral approximation methods (pages 760, 788).

3. The establishment of an artificial anus.

Which of these expedients is entitled to precedence will depend on the condition of the patient and the equipment of the surgeon. If the intestine be greatly disturbed, or the patient be much depressed, a temporary artificial anus, followed later by completer repair, affords the best outlook (page 817).

The Remarks.—It is regarded as wise to evacuate and cleanse the over-distended intestine of a volvulus after reduction, since paralysis and softening of the walls of the gut promptly follow this condition, and, if unrelieved, often cause continued obstruction there from loss of peristaltic function in the presence of a large fæcal accumulation. In our observation the attachments and the direction of the sigmoid mesocolon cause the gut to flex and turn outward to the left when distended with air in experimental instances, a fact which suggests that the manipulation for the reduction of volvulus of the sigmoid be directed from left to right. Often in volvulus of the sigmoid the abdominal incision must be made of a liberal size to permit of the prompt and safe withdrawal of the gut before attempted rectification. The employment of rectal injections and the introduction of the hand into the bowel should not be practiced except for the purposes of diagnosis, and even then the hand must be of small size—about seven inches in circumference—and be inserted with great care. All defects in the structure and vitality of the gut arising from volvulus must be carefully sought for and repaired before the bowel is returned.

The Results.—Established cases of volvulus are hopeless if left to themselves, death usually occurring in the first week. About 50 to 70 per cent die after the relief afforded by abdominal section. Relapses are liable to happen, as the operations for cure afford no protection against this contingency. The shortening of the mesentery by making a longitudinal fold parallel with the long axis of the intestine, and fastening it in place with silk sutures (Senn); fixation by the sewing to the abdominal wall of the sigmoid mesocolon (Roux), or of the bowel itself (Gould), and the fixation attendant on a temporary artificial anus, are tested methods of successful practice. Excision of the distended loop has been suggested (Obolinski).

Neoplasms.—Neoplasms not infrequently cause intestinal obstruction, irrespective of those connected with the rectum. These growths offend by lying upon or by involving the intestinal structure. If obstruction arise

from tumor pressure, the growth should be removed in the manner best calculated to meet the requirements of good surgical technique. If the neoplasm be inseparably connected with the intestinal structure, the portion of intestine and mesentery involved should be removed, along with the growth and enlarged glands, and the ends of the divided gut united by end-to-end, or the lateral apposition method. If the patient's condition or the extent of the disease do not warrant resection, the growth should then be excluded from the intestinal channel by lateral anastomosis of the intestinal loops continuous with the growth, in such a manner as to avoid undue traction on the loops, and at the same time economize as much as possible in the length of the intestinal tract. The technique of these procedures is sufficiently explained already under the consideration of enterectomy and the various methods of intestinal union (page 800 *et seq.*).

Diverticula (Fig. 1052), *bands* (Fig. 1053), *slits, openings,* etc., cause intestinal obstruction not infrequently. The right iliac and pelvic regions

FIG. 1052.—Strangulation caused by an intestinal diverticulum which had wound and fastened itself about a loop of intestine.
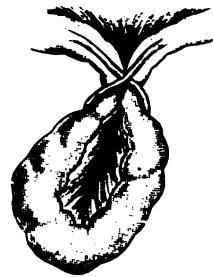
FIG. 1053.—Strangulation of a loop of small intestine by a long ligamentous band.

are the special seats of this class of constricting agents, because of the location there of the vermiform appendix, Fallopian tubes, and uterus, whose natural arrangement and acquired infirmities contribute largely to the frequent presence of intestinal pitfalls in these parts. Meckels diverticulum is also in this vicinity, and its agency contributes about twenty-two per cent of the entire number (hernia excluded) of the cases of obstruction dependent on bands, diverticula, etc.

The abdominal incision, exposure of the contents, and the search for the seat of constriction are each carried out in accordance with the previous description of like procedures. The right side should be examined first for apparent reasons. Bands and diverticula should be removed entirely when possible; they should be ligatured outside the points of division to prevent any bleeding that may attend their severance. The division of a patent diverticulum should be guarded against, since by this occurrence not only blood but infecting products may escape into the peritoneal cavity; the open extremities should be closed by inversion and sewing, the same as in dealing with intestines, and then returned to the abdominal cavity. Compara-

tively little trouble attends the finding and treatment of bands, but if gangrene of the intestine be present or threatened, the case then assumes a graver aspect. However, the detection and treatment of these complications have already been given due consideration. Abnormal openings in the mesentery, omentum, and abdominal walls should be closed to prevent a repetition of the infliction resulting therefrom. Of course, in desperate cases the technique should be abbreviated in a degree consistent with the best interests of the case. As, for instance, if the open ends of a diverticulum be brought out through the abdominal wound and fastened, instead of closed, valuable time will be saved.

The After-treatment.—The after-treatment in operations for relief of the various causes of intestinal obstruction differs in no essential regard from that commended for all severe abdominal operations. The patient is placed on the back with the limbs in a flexed position, and kept there for three or four days at least. The bladder is evacuated with a catheter, if necessary, at regular intervals; a very small amount of milk and Vichy or of koumiss is given daily after the first twenty-four hours for the first week. Nutrient enemata, and rectal injections for thirst, are sparingly administered during the same time. If intestinal distention occur and become annoying, the rectal tube can be introduced high up at intervals, and allowed to remain for a time. Codein or a small amount of morphin can be administered occasionally to lessen pain and nervous irritation. The bowels should be encouraged to move voluntarily rather than from the effect of cathartics; rectal enemata when discreetly employed answer the purpose well.

The Results.—In cœliotomy for acute intestinal obstruction, 68.9 per cent die, and the mortality is twenty-five per cent greater without than with the removal of the obstruction. The death-rate following a complete technique (suturing the bowel is the highest of any plan of action, being 86.6 per cent (Curtis). The earlier the operation the more favorable is the outlook.

Colectomy.—The term colectomy expresses the excision of a limited portion of the colon and the union of the divided extremities. It seems wise, we think, to extend the application of the term to the sigmoid flexure also, rather than employ a newer one (sigmoidectomy) definitely applicable to this part of the large intestine, a course not quite in harmony with the general use of the term colostomy.

The Operation.—The operation of colectomy should be performed as early in the history of a case as possible, to secure the best result. After thorough cleansing of the bowel, the incision to reach the ascending or the descending portion of the colon involved is made along or close to the corresponding linea semilunaris, as circumstances require. The tumor is exposed, and isolated by aseptic surroundings, the contents of the intestine are pushed away from the distal and proximal aspects of the growth, and the bowel is clamped with forceps or tied with gauze at two points about three or four inches apart at each of the respective extremities, the two inner sites of constriction being located close to the growth. The question of the ability to unite the divided ends of the gut should be considered care-

fully before any impairment of the intestinal structure is made.   If the extremities can be united either by end-to-end sewing, by the large circular button of Murphy, or by lateral approximation or other suitable method without undue tension, the operation is continued by division of the intestine at the proximal side close to the inner point of restraint, and the divided ends are cleansed with saline solution and carefully wrapped in sterilized gauze. The distal portion is treated similarly, after which the two ends are united to each other by aid of the means best suited to the case. The isolated portion of intestine, along with the growth and secondarily resulting defects, is removed as in resection of the cæcum (page 854), and the wound is cleansed, drained if need be, and suitably closed.   If it be regarded as impossible to unite the divided ends of the colon safely after excision of the growth, either of the following plans can be pursued:

1. Lateral anastomosis or implantation of the ileum with the colon (ileo-colostomy) at the lowest practicable point beyond the seat of the disease. After this, the disease can be removed or not, as circumstances dictate.   If not, an open end of the bowel is closed and returned to the abdominal cavity, the abdomen is closed and the patient committed to his fate, so far as the morbid growth is concerned.   If removal be practiced, it should be done as has just been described.

2. If the distal part of the healthy colon be beyond the reach of the ileum for the purposes of the proper anastomosis, either one of two courses can be pursued: (a) the closure of the distal end of the colon and the establishment of an artificial anus at the seat of the incision by the withdrawal and fastening outside of the proximal end of the gut; or (b) the closure of both ends of the colon and the anastomosis of the ileum with the descending colon or sigmoid flexure near the rectum. If this plan (b) is practiced the sphincter ani should be well stretched to facilitate the discharge of fæcal matter.   If stretching is not done the rectal contents are not infrequently carried upward along the colon and small intestine by the expulsive efforts of the bowel, instead of downward as is normal.   The writer has had an experience of this kind in an instance of ileo-sigmoid anastomosis.

Paul's Method.—In those instances of colectomy in which the formation of an artificial anus is advisable, *Paul* commends the following method of practice: Through a free incision made over the site of the tumor, clean away the adhesions, ligature, and divide the mesentery well beyond the limits of the growth: remove from the abdomen the loop of bowel and the associated disease: sew together the divided borders of the mesentery (Fig. 1054) and the corresponding adjacent surfaces of the intestine, thus drawing the mesentery outward, so as to lie beneath the bowel: make an opening into the colon at either side of the disease and introduce into each orifice a large-sized Paul's tube (Fig. 1030), ligature it firmly in place, cut away the diseased part, and close the external wound with deep sutures.   Two or three weeks later the intestinal spur is, in suitable cases, removed by the enterotome, and the artificial anus closed in the usual way (page 827).

The Remarks.—Gauze packing, to prevent infection of the wound after operation, is required.   The proximal tube is quite sufficient when attended

59

with closure of the distal end, which closure is accomplished independently or by inclusion in the proximal ligature. *Cripps* strongly approves of the removal of the diseased coil of intestine outside of the abdomen, and its retention there until adhesions have shut off the peritoneal cavity when resected. *Bloch* practices a similar method in three operations: 1, the diseased loop is fastened outside the abdomen; 2, resection and enterorrhaphy

FIG. 1054.—Colectomy, Paul's method. Arrangement of bowel to form spur.

are practiced; 3, later the adhesions are separated and the bowel is returned to the abdomen. If the obstruction is acute, an opening into the proximal aspect of the bowel can be made as soon as protective measures are taken.

McGraw's Method.—This method is most ingenious, and with care should be effective.

The Operation.—With the patient in the dorsal posture, elevate if possible the seat of the obstruction and open the abdomen over it—if otherwise, open the abdomen in the median line; find the obstructed coil and draw it from the abdomen, overcoming restraining adhesions if necessary for the purpose; anastomose together the two limbs of the intestine at either side of the obstruc-

tion by McGraw's method (page 921); close the wound snugly with sutures around the protruding coil, leaving the seat of anastomosis within, and the diseased and adjoining two or three inches of healthy gut without, the abdomen; suture the protruding intestine to the abdominal wall, and ligature and cut off the distal limb just below the tumor (Fig. 1054 *a*); surround the proximal end with gauze, and cleanse, invert, and close the distal end
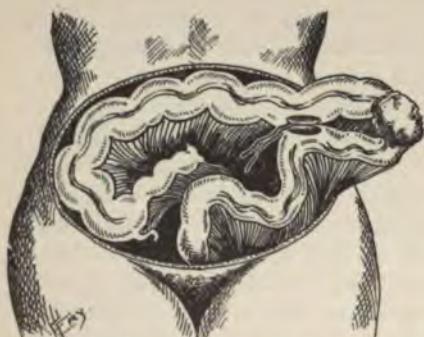
FIG. 1054 *a*.—Colectomy, McGraw's method. Intestine anastomosed.
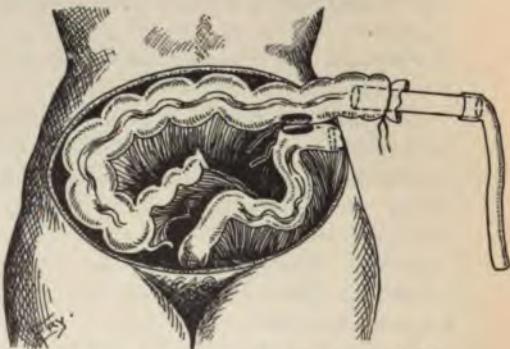
FIG. 1054 *b*.—Colectomy, McGraw's method, tube in place. Intestine anastomosed.

and bury it in the abdominal wound beneath the surface; fasten it in place, close over it the abdominal wound, leaving it thus for good (Fig. 1054 *b*); see that the abdominal wound closely surrounds the proximal protrusion, then seal the whole of the former hermetically with gauze and collodion;

evacuate the contents of the proximal end by means of a trocar with rubber-tube attachment thrust into it; substitute a glass tube (Paul's) with a purse-string fastening (Fig. 1054 *b*) for the trocar after the bowel is emptied of its contents; remove the tube when fæces pass *per rectum* (four or five days) (Fig. 1054 *c*); cut off, cleanse, invert, close, and bury the proximal end as in the preceding instance.

The Precautions.—Pass the ligature while on the stretch, so that the shoulder at the eye of the needle caused by the doubling of the ligature will not make too large an opening in the distended bowel, thereby making the union insecure. If passed while very taut, relaxation causes the suture to instantly fill the point of passage, preventing leakage. The " Smith or McLean needle " is commended for this purpose by McGraw. Sanderson's * needle should answer the purpose well.

The Remarks.—The abdominal incision should, if feasible, be located so as to allow the bowel when extruded to lie as near as practicable in the normal position, and be just large enough to permit the withdrawal of the loop. Other incisions should be closed.

Treves, in idiopathic dilatation of the colon, in a child about six years of age, carried into effect in 1897 † the following supplementary measure, from which, because of the kind of case, we will freely quote:

" By means of an elliptical incision in the skin I isolated and removed the artificial anus, entering the abdomen on each side of the opening. The orifice in the colon I closed by a series of substantial sutures. I found that the gut, which had at one time been so enormously distended, was now of more

FIG. 1054 *c.*—Colectomy, McGraw's method, ends closed and returned to abdomen.

moderate dimensions, and its point of juncture with the narrow tube which represented the lower part of the colon was still abrupt. The narrowed tube had shortened somewhat as the result of removing the distention. The dilatation of the colon extended up to the splenic flexure. Beyond that point the colon was practically normal, although it had evidently been to some degree distended and still showed some hypertrophy of its walls. The colon on the right side was normal, and the whole of the greater bowel had a very free mesocolon. Having found that I could bring the left extremity of the transverse colon to the anus, I isolated and ligatured the left colic artery, and having clamped the bowel divided it at the splenic flexure. I then isolated the sigmoid artery and the superior hæmorrhoidal vessels and ligatured them. The absence of fat in the retroperitoneal tissue rendered this proceeding very simple. At the same time I ascertained that the distribution of the middle and right colic arteries was normal. I then excised the gut repre-

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* Jour. Amer. Med. Assn., November 19, 1904.   † The Lancet, January 29, 1898.

senting the descending colon, the sigmoid flexure, and the upper part of the rectum. I divided the bowel low down in the pelvis below the entrance of the superior hæmorrhoidal artery. A few bleeding points made manifest by the excision required ligatures. The child was now placed in the lithotomy position, and having made an elliptical incision around the evidently narrowed anus I proceeded to remove the anus together with the lower and remaining portion of the rectum. The separation of the rectum from the slender vagina was a somewhat tedious matter. The middle hæmorrhoidal vessels were secured and the lower end of the rectum removed without difficulty. I returned to the abdominal cavity and brought the transverse colon down to the anus, and I secured it by a series of close sutures. The gut was conducted into position by four pressure forceps which were passed into the abdomen through the hole in the perinæum. The operation was concluded by closing the wound in the abdomen without drainage. The child made a speedy and excellent recovery."

Littlewood.*—This operator reports 14 cases of limited colectomy with 10 recoveries. Two rows of catgut sutures were employed, one of the mucous membrane, the other of the sero-muscular coats.

Lilienthal has removed extensively the colon for colitis with a good result.

The *results* (Butlin) of operations on the sigmoid are in 64 cases, 26 deaths. The death rate of sexes about equal. Suture, end to end, 21 cases, 6 deaths; suture, lateral, 1 case, no death. Maunsell's method, 2 cases, no death. Artificial anus, secondary resection, 3 cases, 1 death. Murphy's button, 3 cases, 3 deaths. Block's method, 2 cases, no death.

Operations on the transverse colon are made through a median incision, and have a more serious outlook than those of the remaining parts of the large intestine, because of the commanding relation of this portion of the bowel to the peritoneal cavity, and its intimate connection with the peritonæum itself. Infection here invites general disaster, because of the serous environments and their direct relation to the peritoneal cavity at large. However, the ample serous covering of the intestine yields two advantages: the opportunity for free manipulation and for prompt serous union.

The Comments.—Care should be taken to bring serous membrane in contact around the entire circumference of the colon along the line of union, in order to secure prompt and serviceable attachment of the divided extremities. The point of exit of drainage in ascending or descending colectomy can be so located posteriorly as to be dependent and substantially outside of the peritoneal cavity. *The results* (Butlin) in transverse colon and hepatic and splenic flexure operations in 82 cases, 29 deaths; death-rate much less in females than males. Suture, end to end, 53 cases, 22 deaths; suture, lateral, 2 cases, no death. Maunsell's method, 1 case, no death. Artificial anus, secondary resection, 4 cases, 1 death. Murphy's button, 6 cases, 2 deaths.

Resection of the Ileo-Cæcum.—The resection of this part of the intestinal canal is practiced for the cure of malignant disease, and the earlier

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* Lancet, May 30, 1903.

the attempt is made the brighter will be the outlook. Deferment of operation until symptoms of obstruction appear ought not to be contemplated for a moment, since this course offers no advantages, but profoundly deepens every serious aspect of the case. More or less of the ascending colon is removed.

The Operation.—After thorough cleansing of the bowel and the operation field, place the patient on the back and make an incision about five inches in length, beginning in the line of the anterior border of the axilla, at a point midway between the lower border of the costal cartilages and the crest of the ilium, carry it downward to within an inch and a half of the anterior superior spinous process of this bone, and thence obliquely forward and downward an inch and a half above, and parallel with, Poupart's ligament to a point opposite the middle of this ligament. The tissues of the abdominal wall are divided in consecutive order, the abdominal cavity is opened, and the borders of the wound are drawn apart by means of retraction sutures. Remove adherent omentum by division between tightened ligatures, expose the lowermost part of the ileum and its junction with the colon; strip aside the contents of the lower four inches of the sound ileum with the thumbs and fingers, and raise this portion of intestine from the abdomen; isolate it with moist aseptic sponges, and constrict the extremities of the emptied part with suitable clamps or sterilized gauze passed around the gut through the mesentery and tied; divide the intestine close to the seat of the innermost constriction; cleanse the divided ends of the intestine with an antiseptic solution or cautery, and surround them with gauze. Then expose for four inches the ascending colon, strip away its contents, and constrict, raise up, isolate, and finally divide it in the same manner as the ileum (Fig. 1050); unite the divided ends of the colon and ileum by Maunsell's methods (Figs. 933 and 995), the oblique end-to-end sewing method (Fig. 1055), or, after closure of both ends, by lateral approximation (page 788 *et seq.*), or by lateral implantation of the ileum into the closed (or open) end of the colon (pages 794 and 795). Other plans of action can be employed to meet the indication. If healthy colon be too far away for proper anastomosis with the ileum, the latter can then be anastomosed with the sigmoid (Fig. 1050), thus removing from the field of direct fæcal flow the colon itself. The contractility of the coats will no doubt

Fig. 1055.—Oblique end-to-end sewing of unequal segments. A. Colon. B. Ileum obliquely divided for union with end of colon. C. Longitudinal division, with or without trimming of borders, for the same purpose.

keep it from becoming a receptacle for intestinal contents. The entire isolation of a loop of intestine by closing both ends should not be practiced, since the loop will become distended from its own products if for no other reason, and cause much trouble, and probably require removal or a fistula for relief.

The distal temporary constricting agents are now removed, and as the fæcal flow is allowed to pass along the newly made channel the operator should determine that no leakage is present. The parts are carefully cleansed and restored to the proper position. If the condition of the patient will permit, the patient is rolled somewhat to the opposite side and the resected part is isolated with aseptic surroundings. Small sections of the mesentery, including the vessels, are then tied with silk ligatures, the mesentery is severed with scissors, and the segment removed. If the patient's condition forbids this course, the constricted ends of the part are brought out into the abdominal wound and fastened to await a more favorable time for removal. In either instance of removal, infiltrated structures and enlarged mesenteric glands should always be taken away when practicable.

The Remarks.—The abdominal incision should be extended promptly in either direction if a too limited extent interferes with inspection or proper manipulation. Denuded surfaces in contact with serous membrane should be repaired with peritonæum by transplantation, or by sewing together the serous borders of the denuded area if feasible. The possible technical requirements arising from the local and general demands of a case should be anticipated, in order that they may be promptly and wisely met without impairing the chances of relief. In the instance of small tumors giving a chance for easy inspection of the mesocolon at either side, this structure may be divided between ligatures and the vessels secured, thus liberating the part before the intestine is removed. If the growth be small, it may be properly approached through the linea semilunaris or outer border of the rectus, rolling the patient to the opposite side to the more easily expose and wall off the bowel.

Fig. 1056.—Protective gauze packing at the seat of defective intestinal union (*page 750*).

The Precautions.— If the growth be adherent to the abdominal wall at the line of incision it will be freely cut, unless the anatomical structures in front be recognized as they are divided. If the tumor be thus adherent, it is better to extend the incision above or below to a point of nonadherence, and approach and separate the growth from the wall with the fingers, rather than to attempt to dissect the adhesions apart in the direct line of approach. Careful scrutiny of the line of intestinal sewing should be made, for evident reasons, and any defect must be promptly repaired. Omental grafting (Fig. 1026), to cover a defect, can be practiced, and gauze packing around the line of junction should always be inserted and permitted to remain three or four days, unless the abdominal wound be sooner closed (Fig. 1056). *The results* (Butlin) in removal of cæcum and ascending colon, of 95 cases, 29 deaths, 20 per cent better in females than males. Su-

ture, end to end, 51 cases, 21 deaths; suture, lateral, 5 cases, 1 death.   Artificial anus, secondary resection, 9 cases, 2 deaths.   Murphy's button, 7 cases, 2 deaths.   Senn's plates, 3 cases, 1 death.   Maunsell's, Paul's, and Mayo-Robson's method, each 1.   Paul's died.

The Removal of the Vermiform Appendix.—The removal of the vermiform appendix for relief from manifestations formerly regarded as due to typhlitis is a comparatively modern procedure and the product of the genius of American surgeons.   The diagnosis of appendicitis and the technique of the operation for its relief are matters of such general medical and surgical attainment now that prompt and effective treatment should be a part of the medical history of every community.

The Anatomical Points.—The appendix varies in its origin, direction, size, nature of the contents, etc., sufficiently to warrant a little delay in order that the surgical importance of these variations can be given consideration.   In the majority of instances the appendix arises from the cæcum at a

FIG. 1057.—The cæcum and appendix.   *a.* Fibrous band.   *b.* "Free" portion of appendix.   *c.* Ileum.   *d.* Subperitoneal portion of appendix.

point about an inch below the ileo-cæcal junction posteriorly.   There are *two good guides* to the location of the base of the appendix, a superficial and a deep one.   The former is known as "McBurney's point," and is located as near as may be—about two inches internally—to the anterior superior spinous process of the ilium and on the imaginary line (Fig. 1061, *a*, *) extending between it and the umbilicus.   It is proper to say, however, that the relation of this point to the anterior superior spinous process, when indicated on the surface, will depend entirely on the location of the part of the surface to which the pressure is applied and the direction of its application.   Therefore, some say that it is located midway between the spine and the umbilicus, and others at different situations.   The latter guide is the fibrous band (Fig. 1057, *a*) that characterizes the cæcum and large intestine, and arises at the base of the appendix.   As has been shown by the author already, founded on the examination of one hundred and forty-four post-mortem cases, the appendix extended inward in twenty-four per cent, was behind the cæcum in twenty, and entered the pelvic cavity in fourteen per cent of the cases, and in each instance this position was twice as frequent in the male as in the female, because of the greater length of the appendix of the former.   In the remaining instances the directions were upward, behind, or to the outer side of the cæcum, upward behind the colon, downward, or in other directions closely related to the preceding.   But enough has been stated already to establish the fact that the position of the appendix varies greatly, and indeed the local mani-

festations of a diseased appendix depend much on the position it occupies.
Little need be said of the size except as bearing on its relation to the con-
tents and the localization of the organ by abdominal palpation. In forty
cases measured, irrespective of sex, eighty-nine per cent were five sixteenths
of an inch in diameter and contained fæcal or other foreign material. The
remainder were of a less diameter and contained less frequently foreign
matters. In some instances we have been able to locate the appendix in the
living by abdominal palpation in the absence of pain and tenderness. How-
ever, when the variations in location, direction, and size of the organ are
noted, it is not strange at all that it is so frequently undetected; and, too,
since the increase in size is in direct proportion to the amount of abnormal
contents, should not, indeed, the advantages to be gained be thoughtfully
compared with the dangers incurred by manipulation before the attempt is
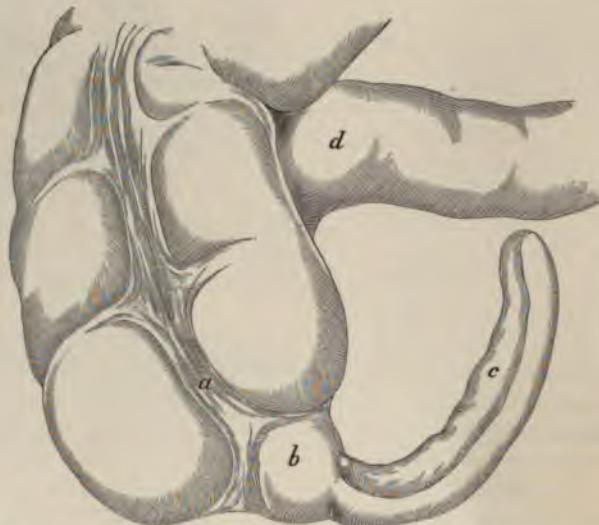
FIG. 1058.—The cæcum and appendix (fœtal type). *a.* Fibrous band. *b.* Base of
appendix. *c.* Meso-appendix. *d.* Ileum.

made? In sixty-seven per cent of the cases (one hundred and twenty-four)
the appendix contained abnormal material, which was seen in fourteen per
cent more of the male than of the female sex. The mesentery of the appen-
dix varied much in extent and area. In forty per cent half or less of the
length of the appendix was surrounded with peritonæum (*b*), or "free,"
as the expression goes, and for this reason possessed a greater power for
evil when diseased. Cæca differ in their types (Fig. 1058). The situation
of the right linea semilunaris should be fixed, not only that it may be
divided if needs be, but also to prevent, if not desirable, entrance to the
sheath of the rectus muscle. The relative direction of the fibers of the
respective structures that overlie the cæcum should be carefully noted, also
the relation of the cæcum to contiguous vascular, nervous, and other struc-
tures (Fig. 1059), not only to enable one to recognize the structures in

proper order, but also to facilitate an intelligent separation of their fibers should circumstances require it.

For the purposes of operative treatment of appendicitis five classes of cases are considered, the arrangements of which are suggested by the relations noted to exist between their respective histories and the conditions revealed by operation, together with their relative danger to life:

1. Acute appendicitis characterized by sudden perforation and diffuse septic peritonitis.

2. Subacute appendicitis of insidious development usually complicated with perforation, attended with more or less circumscribed suppuration, and possibly by phlebitis, abscess of the liver, subphrenic abscess, abscess in the pelvis, etc.

3. Acute appendicitis with perforation and circumscribed suppurative peritonitis.

4. Recurrent and relapsing appendicitis, with varying intervals of attack which unfit the patient for the duties of life; these cases not infrequently terminate fatally.

5. Acute catarrhal appendicitis with or without involvement of the walls of the appendix and with plastic inflammation.

The operative technique of appendicitis demands the application of the rules of asepsis in a most rigorous manner. The operation field, as well as everything brought in contact with the wound and employed in the operation itself, must be made thoroughly aseptic with painstaking care. Abundant hot saline solution, ample sponges and aseptic cloths, iodoform gauze, and drainage agents should be provided. Stimulating agents for the immediate and remoter treatment of shock are needed (page 121). In the absence of the stereotyped operating table of hospital life, the extemporized one of humble station or urgent demand will fulfill adequately the necessary requirements of the occasion (Fig. 57, vol. i). A table allowing postural changes of the patient may be of advantage in the examination of the pelvic cavity
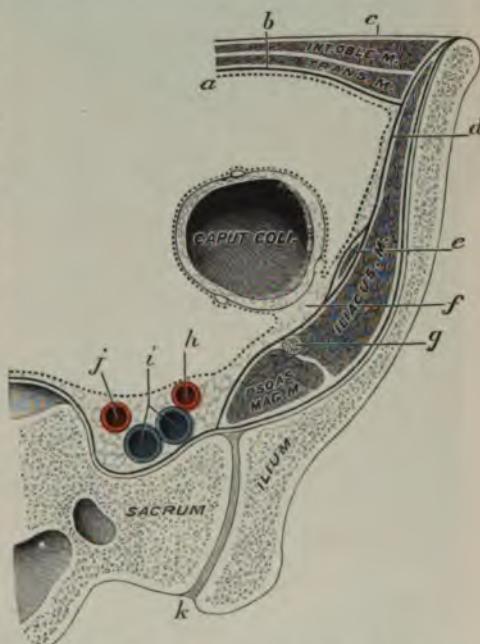
Fig. 1039.—Transverse section through pelvis at the level of anterior superior spinous process and sacro-vertebral angle. *a.* Dotted line, indicating peritonæum. *b.* Transversalis fascia. *c.* Aponeurosis of external oblique. *d.* Iliac fascia. *e.* Psoas parvus. *f.* Post-peritoneal connective tissue. *g.* Anterior crural nerve. *h.* External iliac artery. *i.* Iliac veins. *j.* Internal iliac artery. *k.* Sacroiliac junction. These relations are important in estimating the influence of the situation of the appendix on the symptoms, signs, and complications in disease of the organ.

to expose the presence of diseased action of products, but it is not indispensable.

The Incisions.—The primary incisions (Fig. 1061) are mainly located on the right side between the linea semilunaris at the inner and the iliac

FIG. 1060.—Instruments employed in operation for appendicitis.

a. Scalpels. *b.* Bistouries. *c.* Forcipressure. *d.* Curved and straight scissors. *e.* Thumb forceps. *f.* Needle-holder. *h.* Retractors. *i.* Sponge-holder. *j.* Wicking surrounded by fenestrated rubber tissue, for drainage. *k.* Rubber drainage tube. *l.* Needles, sutures, and traction loops. *m.* Gauze for drainage. *n.* Glass tubes, for rinsing and drainage. *o.* Tenaculum. *p.* Catgut and silk ligatures. *q.* Steel probe, to determine patency of lumen with cæcum, and to cauterize the mucous membrane of the stump. Broad retractors and Paquelin's cautery are much needed.

spine and Poupart's ligament at the outer limit. Differently directed incisions are advised in this operation: the vertical and the oblique are the ones usually employed. Each of these incisions begins about an inch above a line extending from the anterior superior spine of the ilium to the umbilicus; each is made about three inches in length at the outset and is modified thereafter as may be advisable. The oblique intermuscular ("gridiron") dissection and the oblique free division (page 869 *et seq.*) of the tissues at
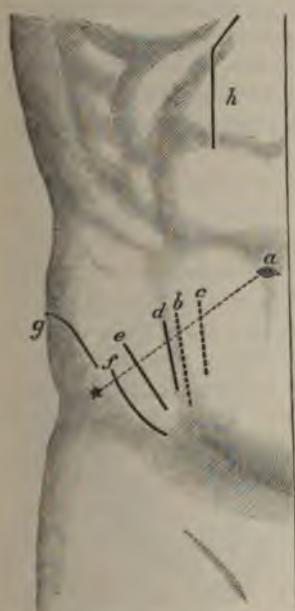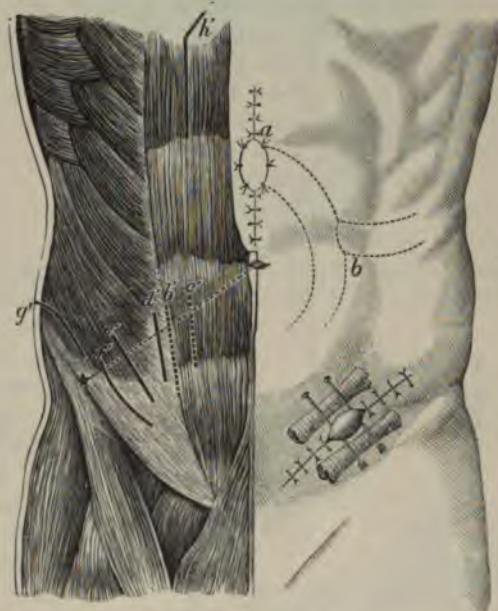
FIG. 1061.   FIG. 1062.

FIG. 1061.—The superficial incisions. *a*, *. Imaginary line between anterior superior spinous process and umbilicus. *b*, *c*. Lines of incision in the Battle-Kammerer-Jalaguier method. *d*. Vertical incision. *e*. McBurney incision. *f*. Hypogastric incision. *g*. Vischer's incision. Other incisions are omitted to avoid confusion, but some of them will be described in the text. *h*. Robson's cutaneous incisions for exploration of bile-ducts.

FIG. 1062.—The deep incisions in their muscular and aponeurotic relations. *a*, *. Imaginary line between anterior superior spinous process and umbilicus. *b′*, *c′*. The Battle-Kammerer-Jalaguier method. *d′*. The vertical incision method. *e′*. The McBurney (gridiron) method. *f′*. The hypogastric method. *g′*. Vischer's method. Ileo-colostomy shown at the left. *a*, *b*. Maydl's method of jejunostomy (page 924). *h′*. Robson's muscular division for exploration of bile-ducts. Left inguinal colostomy (page 824).

substantially the same location are employed, the latter less frequently than formerly, because of hernial sequels which happened in about five per cent of the cases (Fig. 1062). The vertical incision is made through the outer margin of the linea semilunaris, and preferably involving the terminations of the transverse muscular fibers at this situation. *Modified incisions* (page 872) are important in special cases.

The Remarks.—The careful union and prompt repair of the divided ends of the muscles and of the separated borders of bundles of this tissue are followed by as firm and often by securer union than that of divided aponeurotic structure. The location, direction, and extent of a primary incision should be regulated much more by the seat of disease and the prospective utility of the incision than by a stereotyped rule of practice. A healthy appendix, or one but slightly diseased and non-adherent, can readily be removed through an incision an inch or two in length, but in reverse conditions the length of the opening should always correspond with the demands of safe practice. The oblique intermuscular separation (Fig. 1062, e') exposes the patient to the minimum danger of hernial sequels, the vertical (d') and the free oblique to the maximum. The modified methods of approach to the seat of disease will be considered as the conditions demanding their adoption appear.

The Treatment of the Appendix.—The appendix should always be removed when consistent with the welfare of the patient. If adherent, it should be cautiously separated from its connections, from the base downward or apex upward, as convenience and care may dictate, observing that no portion of it remains behind. Its mesentery should be tied with catgut in one or more sections, then divided with scissors, and the appendix, raised up along with the wall of the cæcum into the wound, isolated by aseptic surroundings, and perhaps caught with forceps or loosely with a ligature, close at the base (Fig. 1063), should be cut off about half an inch from its origin and a sleeve of serous membrane turned up (Fig. 1064). The patency of the lumen of the stump is then established before the ligature is applied by the introduction through it into the cæcum of a probe (Fig. 1060, q). After ligature the stump may be treated by one of the following methods:

FIG. 1063.—Fowler's treatment of appendix, showing base brought by ligature, distal ligature to prevent escape of contents, and line indicating division of the mucous membrane.

a. By drawing the serous coat over the ends of the inner structures and uniting it there with fine silk or catgut.

b. By suturing together the outer and middle coats after removal of the inner (mucous) by cutting or cautery.

c. By depressing a short, flexible stump into the wall of the cæcum (Fig. 1065) and burying it there by joining together with sutures the borders of the cæcal depression (Fig. 1066).

d. By severing the stump close to the cæcum, inverting the borders and uniting them as before with sutures.

e. By destroying the mucous lining of the stump with cautery, and ligaturing it with catgut "within the cauterized area." After

which the end is reduced to small proportions by trimming and cauterization (McBurney).

f. By first depositing around the stump, near its base, a purse-string suture going through the superficial tissues of the cæcum, leaving it untied. Then cut off the appendix half an inch from the base, stretch the lumen by the introduction into it, and the separation of the blades of fine forceps; invaginate the stretched tissues into the cæcum with forceps, and hold them there while the suture is being tied (Dawbarn).

g. By applying to the base of the appendix, a quarter of an inch from its cæcal origin, a provisional catgut
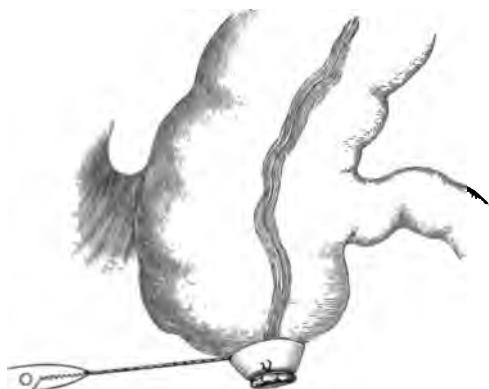
FIG. 1064.

FIG. 1065.

FIG. 1064.—Fowler's treatment of appendix, showing serous sleeve turned up and end of stump tied.

FIG. 1065.—Fowler's treatment of appendix, showing stump buried in wall of cæcum.

ligature. Isolate the appendix with gauze, and sever it beyond the ligature with scissors; cauterize the lumen and the end of the stump, and apply a second catgut ligature to reinforce the first (McCosh).

The Remarks.—The adoption of any particular method of treatment of the appendix is not of as much importance as is the practice that eliminates from the stump and its environments infecting agents and possibilities. It often happens, on account of disease of the appendix at its origin or of the wall of the cæcum near by, that the practice must be made to conform to the principles of safety rather than to imitation of any stereotyped methods.

In suppurative cases, the ligature of the appendix before or after cauterization of the mucous membrane and extremity is quite sufficient. Only durable catgut ligatures should be employed in the infected cases, since silk ligatures under those conditions will invite and may perpetuate the infec-

tion. Not infrequently gangrene and other destructive changes at the base of the appendix will render the whole or part of the structure unavailable

FIG. 1066.—Fowler's treatment of appendix, showing sutured borders of cæcal depression.

for the purposes of repair. In such cases as these the utilization of the healthy parts, combined with cæcal inversion and sewing, will answer the purpose. When the whole or a part of a diseased appendix is imbedded in the limiting wall of an abscess, it is usually wiser to slit up and curette the imprisoned part, leaving it then to Nature's care, than to remove it at the risk of causing increased infection. Other modifications of treatment of the appendix will be remarked farther along, as circumstances may require.

Acute Appendicitis, characterized by Sudden Perforation and Diffuse Septic Peritonitis.—Through the vertical—made at the outer muscular border (Fig. 1061, *d*)—or by an oblique free division (page 861) pass rapidly down to the peritonæum. Arrest hæmorrhage, thoroughly cleanse the operation field and incise the peritonæum, which will not in these cases be adherent to underlying structures. Introduce traction sutures through the entire thickness of both borders of the wound and open the wound wide, preventing at the same time the escape of distended intestines with the hand, or by thin, flat sponges or taped wipers. Cleanse the field with wipers wet with the hot saline solution, and locate the fibrous longitudinal band at the inner aspect of the cæcum (Fig. 1057); follow it downward carefully to the base of the appendix (remembering that it may be extra-peritoneal and passing up beneath the cæcum), and push aside the intestines and hold them with the fingers or gauze so that the appendix can be located, increasing the external incision, if necessary, only enough to permit prompt and free inspection. Raise up the appendix, remove it quickly by one of the simple methods, applying cautery if time will permit. As the chief danger in this class is death from shock and sepsis, which latter has already involved more or less of the peritoneal cavity, and is rapidly spreading, unhindered by adhesive limitation, the proper cleansing and draining of the cavity are the *desiderata*. The site of the appendix and the contiguous tissues are promptly cleansed and fæcal concretions removed. The examination is quickly though cautiously extended inward in various directions in search of collections of fluid, the pelvic cavity and intestinal folds being carefully inspected in this regard. Small, fine sponges on holders, following closely beneath a carefully advancing finger, are vigilant agents of discovery and removal of offensive fluids. The visible variations in the degree of inflammation of the intestine will speak unerringly of the direction and vigor of the disease as the examination progresses. The effective cleansing of the peritoneal cavity (page 745) is very much hindered by the intestinal distention that attends this class of cases; in some, in fact, in which this manifestation is marked, it is very doubtful if even earnest attempts in this line of action meet with a commensurate reward. The forcing between the folds of intestines of fluids that do not promptly return can but increase the extent of the disease. Therefore, we are disposed to

believe that eventration in proper cases offers no less chance of relief than forced and ineffective douching of the abdominal cavity. The hot saline solution (115° F.) is poured freely into the opening, and caused to enter the pelvic cavity and pass among the intestinal folds by pushing aside and separating the intestines with the hands. The fluid is thus repeatedly introduced when practicable and caused to mingle freely with the intestines by agitation, with the hand on the abdomen and in the cavity, and then permitted to escape by turning the patient on the side until it bears no gross evidence of infection. *Blake's* irrigating tube with a central cylinder for return flow is an admirable agent for cleansing purposes. The patient should then be raised somewhat to cause the fluid to collect in the pelvic cavity, from which it is carefully removed by large, soft, aseptic sponges successively introduced, remembering that frequent or vigorous sponging causes superficial traumatism of serous surfaces. Careful inspection of intestinal loops, aided by temporary removal of each, and attended with the wiping away of infecting agents therefrom with soft sponges, as well as the absorption of vicarious collections of fluid by the same agents, characterizes the cleansing process. Drainage is a necessary element of treatment, especially in the presence of necrotic tissue (page 747). The pelvic cavity, the planes beneath and between the intestines, and especially the serous fossæ (page 747) associated with the cæcum, should be carefully drained. The glass drainage tube (Fig. 904) surrounded by and containing gauze is suitable for the pelvis; candle-wicking incased in perforated rubber tissue should be employed (Fig. 1060, *j*). The latter agent can be wisely introduced between the intestinal folds, extended in necessary directions, and caused to escape at the abdominal incision and other openings made for the purpose. Oiled strips of iodoform or of simple gauze can be introduced in a similar manner. Finally, the region of the appendix and the shortened (by suturing) wound itself are loosely filled with gauze. Later the fluid collecting in the glass drainage tube is withdrawn at intervals with a small rubber tube connected with the nozzle of a syringe arranged for the purpose, which is kept in an antiseptic solution when not in use. Additional hot saline solution may be introduced at the same time. The tube is removed early (page 748 *et seq.*), and a strip of gauze is left in its place when indicated. The other agents employed for drainage are removed as soon as they have served their purpose.

The Remarks.—As much as possible of the fluid that may be in the abdominal cavity should be caused to run out through the opening before the saline solution is introduced for flushing, to prevent infective dissemination that may attend the act. A perforated rubber or glass tube, carefully guided by the finger, is frequently advantageous in cleansing the *culs-de-sac* that often harbor infection. The leaving behind in the peritoneal cavity, in these cases, of a quart or more of the saline solution is beneficial (page 613). The posture of the patient is regulated by the demands of the case (page 748). Should vomiting occur, caution is required to prevent the escape of intestine through the drainage opening.

The Results.—In this class of cases the operative results are unfavorable, and it is unexpected indeed if recovery takes place when the peritonitis

has become general. The fact that an incalculable degree of involvement of the serous membrane is a part of the earliest surgical history makes the prognosis unfavorable at the outset, and emphasizes the advisability of early operative procedure when possible. The outcome is no doubt better than formerly, because of the improved knowledge of their nature and of the salutary influence of free flushing of the peritoneal cavity with hot saline fluid and of efficient drainage. However, the difference in the results reported by equally competent observers suggests strongly the fact of a corresponding difference of understanding regarding the diagnosis of the extent of the condition. *The rates* reported vary from total demise to thirty-three and a third per cent recovery.

Subacute Appendicitis of Insidious Development, usually complicated with Perforation, attended with more or less Circumscribed Suppuration, and possibly by Phlebitis, Abscess of the Liver, Subphrenic Abscess, Abscess in the Pelvis, etc.—In the second class the disease is exposed through a vertical modified incision (page 872), as circumstances require, and the tissues are divided down to the peritonæum. If a pronounced degree of suppuration have taken place beneath the line of incision, and the peritonæum there have become adherent beneath, the deep tissue will be œdematous, the fatty portion presenting a yellow aspect. If fluctuation be felt, the solution of the problem is easy. However, the elasticity of an adherent intestine should not be mistaken for that of pus, and the remaining tissues must be cautiously divided in any event. If the deeper tissues be but little changed, or not at all, in this regard, a deepening of the incision will quite surely involve the general peritoneal cavity. Therefore, every precaution against the spread of infection, by repression of the intestines and packing of the borders with taped wipers, should immediately follow this advancing step. In the former instance, the use of a hypodermic syringe, sharp probe, grooved director, point of the knife or closed scissors can be used to gain an entrance by penetration or friction into the thin-walled cavity. Wipe away promptly the pus as it appears, and enlarge the opening by stretching until the finger can be introduced into the abscess, by means of which the relation of the abscess wall to the abdomen in front can be safely estimated. The opening is then increased in length upward or downward, as the intestinal relations and the pus collections suggest. Draw the lips of the wound apart with retractors or traction sutures, and with the finger examine the walls of the abscess for openings or weak points, and the bottom for the presence of foreign bodies and for the appendix. If the abscess be thin-walled at points, or the wall be torn in the manipulation, it should be wiped clean and repaired at once by a careful packing with gauze. Rinse the cavity lightly with the hot saline solution, the stream being directed or modified in force by the interposition of the hand; separate the deeper walls with the fingers, and wipe away cautiously with small, soft sponges or wipers the fluid remaining in the cavity; a dilute solution of peroxide of hydrogen is useful for cleansing purposes. Locate and remove the appendix, unless its removal may rupture the limiting wall of the abscess at its peritoneal aspect so as to cause extended infection. Often then the appendix can be divided at the base, the stump treated as in other suppu-

rative cases. In this class of cases, especially, the base of the appendix should be located first in all instances, and its course in the abdomen carefully followed, for along it not infrequently the purulent canal passes up behind the ascending colon to the liver, or into the pelvis, etc., involving large vessels and establishing isolated pus collections. The diversity of the direction of the appendix within the abdomen should be considered in the exploration of these cases (page 857). The external wound must be enlarged, and the walls of the purulent canals and collections separated, carefully examined, and, when necessary, repaired with iodoform gauze and drained, as the examination progresses. If the appendix extend toward the pelvis, it may enter that cavity and perforation occur at the intrapelvic part of the organ, causing pelvic abscess. The careful exploration of the pelvic cavity, with one or more fingers introduced through the vagina or rectum will, in these cases, often elicit the presence of tumor there, attended with pain and tenderness. These pus collections can be reached from the original incision by careful separation of the intestines with the fingers in the course of the appendix, accompanied with simultaneous tunneling of the canal with suitable drainage agents. The not infrequent practice of blindly fumbling among the intestines for pus with the finger, without advancing gauze fortification, is as dangerous as unfit, sometimes causing perforation of the intestine, and always heightening the danger to the patient of general peritoneal infection. Not infrequently pelvic abscesses due to appendicitis are opened through the vagina or rectum, especially in depressed cases and those in which the uncertainty as to surgical technique makes this the safer procedure of the two. The appendix is rarely indeed situated extraperitoneally and upward behind the ascending colon (two per cent), as may happen in this class. Under these circumstances, with high perforation and cellular inflammation, the abscess may require opening above the crest of the ilium (Fig. 1061, *g*).

The Remarks.—If abscesses be found in the pelvis it is wiser to approach it through an incision in the median line, or through a modified incision (page 872), than to practice inadequate, harmful, and prolonged manipulative efforts through the primary incision. The author has observed several cases of this class complicated respectively with subphrenic abscess, abscess of the deep tissues of the body, and high perforation of the colon. Presumptively the appendix extended upward, beneath the peritonæum and behind the colon in each instance. It sometimes happens that an appendix of abnormal length and unusual location causes in distant parts of the abdomen symptoms of an acute or subacute nature. For these reasons appendicitis at the left side is not unheard of, and should therefore be regarded possible without transposition of viscera.

The Results.—In this class of cases the insidious development in numerous instances and the consequent uncertainty of diagnosis, the latter depending not infrequently on the unusual length and direction of the appendix, are attended with such doubt and delay in proper treatment as to deprive the patient of the salutary benefits of operative action. Especially is this true when hepatic or venous complications ensue. Fortunately, however, these cases are comparatively rare.

The outcome of appendicitis is less favorable when its manifestations are located in unusual and out-of-the-way places—those which blind diagnostic acumen and hinder proper practice. For these reasons only the final results in cases with pelvic involvement are often less favorable than those of a similar character located nearer to hand.

Acute Appendicitis with Perforation and Circumscribed Suppurative Peritonitis.—In the third class the vertical or oblique incisions can be made (Fig. 1061). As a general proposition (page 862), properly repeated in connection with this class of cases because of their frequency, the incision that affords the best opportunity for exploration and drainage and avoidance of peritoneal infection, with the least liability thereafter to parietal infirmity, should be adopted. Therefore, tumors located near the median line should be incised at their center, either through the ordinary or the modified vertical incision; those nearer the crest of the ilium and along Poupart's ligament at the external aspect (Fig. 1061, *f*). Little can be said regarding the treatment of abscess in this class not expressed already in the description of the approach to, and treatment of those of the preceding class. Here, as there, the conditions of the deep tissues of the abdominal wall indicate their relation to suppuration, and suggest like means for the avoidance of infection. The appendix is ligatured with catgut, divided, and the mucous membrane of the stump cauterized. In some instances the appendix is missing entirely, or sloughing shreddy remnants only attest its past existence. The cavity is cleansed by wiping with soft sponges, aided by gentle flushing with the hot saline solution, or a solution of peroxide of hydrogen. Any defects in the lymph environment that were present at the outset, or that occurred during the cleansing, must be repaired at once with iodoform gauze. Finally, the wound is dressed lightly with iodoform gauze, arranged in a parallel manner, and the whole overlaid with sterilized or bichloride gauze held in place by an abdominal binder. The wound is usually redressed at the end of forty-eight hours. Still, an earlier period may be necessary or a later one suffice, depending on the character and extent of the wound and the local and constitutional manifestations of infection. Visible soiling of the dressings calls for their prompt removal. The wiping out of the wound with soft sponges or pieces of gauze supplemented with peroxide of hydrogen, cleansing of wound recesses, and loose dressing with gauze, aided by a constantly increasing tension of the binder to limit the extent of cicatrization, characterizes the local treatment in septic cases.

The Remarks.—These cases are of comparatively common occurrence, and usually the surgical technique can be readily carried into effect. The deep incision into the abscess differs but little from that of common abscesses elsewhere in the body, except when peritoneal adhesion in front is in doubt; then, careful approach is requisite, and cautious packing needed if adhesions be absent, to avoid further infection. The practice relating to the removal and treatment of the appendix in other cases is applicable to this. *Cautery* may be employed here and elsewhere if desirable.

The Results.—The operative prognosis is good, provided adhesion between the visceral and parietal peritonæum has taken place, or the spread of infection is prevented by suitable gauze packing in the absence of adhe-

sion before the pus is liberated. The effort to remove the appendix when it is imbedded in the limiting wall of the abscess often provokes extension of the disease without offering a commensurate advantage to the patient. Determined efforts of this character should not be made except for better reasons than have yet come to the notice of the author. Enucleation from its serous covering is sometimes practiced in these cases. The reported mortality operations in acute cases are misleading, as it rarely happens that the important influences contributing to an unfavorable result appear in the statements. However, the rate in acute cases of all classes is about twenty per cent.

Recurrent and Relapsing Appendicitis, with Varying Intervals of Attacks which unfit the Patient for the Duties of Life; these Cases not infrequently terminate fatally.—The cases of this class are comparatively frequent indeed, and their relatively benign character invites prompt action which affords safe relief from established or prospective danger. The appendix may be either entirely free or more or less adherent, and sometimes associated with limited old suppurative changes. The parietal peritonæum is rarely adherent to the subjacent parts, therefore, its division trespasses at once on the general peritoneal territory. *Two methods* of approach are practiced in these cases: one the ordinary (free incision), the other the "gridiron" method (Figs. 1061 and 1062, *e* and *e'*). In the former, the respective tissues are divided along the line of an oblique incision carefully down to the peritonæum which is cautiously severed, after which the cæcum is exposed, and the fibrous bands are noted and followed down to the base of the appendix, which with the finger is drawn gently into the wound along with the anterior surface of the cæcum, carefully examined to note its entirety, isolated with aseptic gauze, cut off, and treated according to the method approved by the operator. If the appendix be adherent or involved in old inflammatory processes, as indicated by examination with the fingers, the organ is carefully exposed and the general peritoneal cavity shut out by packing the borders gently with gauze. The appendix is then cautiously disconnected from its adhesive environments—carefully noting that no portion remains behind—raised up, isolated, and removed. In both instances the operation field is cleansed with the hot saline solution, and the wound closed in those cases that present no evidences of present or prospective infection. In the others, the previous location of the appendix and the wound itself are packed loosely with gauze, or simply drained as usual, as in the cases of established infection. If the two layers of peritonæum should happen to be adherent, the main caution consists in gaining the site of the appendix without entering the canal of an interposed intestine. However, if the tissues in turn be accounted for as divided, and the relation of the tissues that immediately underlie the transversalis muscle be noted, and the advance be made slowly through the tissues by friction severance, no pronounced involvement will happen. If the intestine be opened, the incision should be closed at once by sewing and the operation continued.

The Remarks.—The intervals of quiet of recurrent cases, and the paroxysmal manifestations of the relapsing, constitute significant differences in

these kinds of appendicitis. Although neither of them is as dangerous as is a primary acute attack, still, either should be regarded important, as it may promptly prove fatal. A second attack occurs in about twenty-one per cent of acute cases. This class of cases is often of a catarrhal nature.

The Results.—In the fourth class the prognosis of operation during the attack is much better than in acute appendicitis. If performed in the intervals of the attacks the death rate is scarcely two per cent. In fact, the operation at this time exposes the patient to less danger than does the presence in the abdomen of the diseased appendix. The "gridiron" plan is especially applicable to these cases, since the confinement in bed and hernial sequels are reduced to a minimum. It should be remembered, however, that secondary attacks may expose the patient to as great, and even greater danger than did the primary acute one.

The Gridiron Method (McBurney).—The gridiron method is indeed a commendable plan of action in those cases which admit of immediate closure of the abdominal wound. It is beneficent in the prevention of the hernial sequels following other common methods of entrance that too often plague the patient and vex the surgeon. The primary incision (Fig. 1061 and 1062, *e* and *e'*) is made along the oblique line down to the aponeurosis of the external oblique muscle, the fibers of which are separated in the line of their course to the proper extent; each succeeding layer of tissue, as it appears after division of the intermuscular planes of fascia, is treated in the same manner until the transversalis fascia is reached. This fascia and the peritonæum are divided independently in the line of the separated fibers of the transversalis muscle, the appendix is located, raised upward into the wound, and treated as non-infective. The borders of the respective tissues of the wound are united to each other with catgut in the reverse order of separation. Superficial drainage with a few strands of catgut or a similar agent is sometimes employed. The wound is dressed in the usual manner, and the patient kept quiet for twelve to fourteen days. Owing to the different directions of the lines of separation of the tissues, not less than four retractors or retraction sutures are essential to the proper exposure of the underlying structures.

The Remarks.—This method of practice is best adapted to non-suppurative cases and those in which the area of diseased action is of a limited extent. However, many surgeons employ this plan in suppurative cases, especially in those of limited extent, in order to gain the benefits for the patient of the greater strength from uncut tissues at the seat of the opening when healing ensues. If the magnitude of the disease be large, or the appendix be of uncommon length or in an unusual position, the opening is often of inadequate size for the purposes of safe and thorough practice. Under these circumstances its extent may be increased by stretching with retractors and by suitable division in the requisite directions of the restricting tissues (page 872). It is proper to say at this time, we think, that the rule of action relating to the extent of incisions and their relation to proper observation and manipulation of both diseased and healthy structures (page 49, vol. i) applies in abdominal surgery with greater force, if possible, than to operations elsewhere of the body.

The Results.—Inasmuch as this method of procedure is especially applicable to chronic cases and to interval operations, the death rate, though modified, of course, by the experience and skill of the operator, is exceedingly small, varying from *nil* to four or five per cent.

Acute Catarrhal Appendicitis with or without Involvement of the Wall of the Appendix and with Plastic Exudation.

—The fifth class of cases, especially those characterized by extensive fibrinous exudation, are often attended with unique clinical expressions and an astonishing amount of fibrinous deposit. They are temporarily regarded, not infrequently, as sarcoma of the cæcum. Either the vertical or oblique incision can be employed in this class of cases. If the tumor be not large, the " gridiron " plan of action may be adopted. In the instance of a large deposit, the visceral and parietal layers of the peritonæum will be adherent to each other, and thus shut off at once the general peritoneal cavity from the line of incision. If the amount of exudate be small this adhesion will not happen, and the intestines must be pushed aside and held there with gauze as soon as they appear in the wound. The search for the appendix in the fibrinous mass should be conducted with care to avoid injury of hidden tissues. If the exudate does not involve the cæcum, or can be separated from it, the base of the appendix can be exposed through the guidance of the fibrous band leading to it, and, finally, the entire organ can be enucleated from its firm environment, noting carefully that no part of it remains behind to breed infectious processes. If the new tissue can not be separated from the wall of the cæcum without endangering the integrity of the structure, the deposit should be carefully pried open in the long axis with the handle of a scalpel, beginning at the point of established origin of the appendix. The appendix is then carefully and completely removed, the stump treated according to the nature of the case, and the wound closed if the presence in it of infective agents be not suspected. If decided infection have been present, the wound in the abdominal wall should be shortened as much as possible with sutures, the remaining wound cavity having first been dressed lightly with gauze to the bottom or a cigarette drain (page 748) introduced. The fibrinous induration disappears rapidly and completely after the removal of the appendix.

The Remarks.—Appendicitis of this nature, while comparatively unusual, happens sufficiently often to frequently perplex the medical attendant regarding its true nature. In more than one instance the tumor on exposure has been mistaken for sarcoma of the cæcum, and the cæcum removed by competent surgeons. The writer recalls a somewhat recent case of this kind in his own practice, in which, owing to the large size of the tumor, the presence of extensive mesenteric glandular involvement, the absence of any local evidence of peritonitis, the feeble state of the patient, and the indefiniteness of the history of the case, inoperable sarcoma of the cæcum was diagnosticated. The abdominal incision was closed, and the patient made a prompt, complete, and final recovery. In another, thought to be an inoperable sarcoma, the patient promptly recovered.

The Results.—The results from removal of the appendix are excellent, and none other than a favorable outcome need be expected. Rapid final

60

absorption of the plastic material follows, and in fact may follow without removal of the appendix, but in the latter instance is likely soon again to return.

The Removal of the Appendix during the Interval.—In 1888 Treves removed the appendix during the interval in a case of relapsing appendicitis. Since that time the wisdom of the plan has become well recognized by the profession, and is now being quite generally practiced. The exact period of time after an attack before operative interference is advisable can not be definitely stated, because of the variations in the degree of the infliction and in the powers of recovery. Therefore each case should be decided upon its own merits, remembering that the completer the recovery the less is the danger, and consequently the simpler and safer is the execution. But since the removal, after practical subsidence of the manifestations of the attack, is safer for the patient than is the retention of a rebellious appendix, the operation should be performed, if possible, before the appearance of another attack. An interval of two or three weeks may be regarded as suitable in the majority of cases. Drainage is seldom needed in these cases.

The Results.—The results of operation at this period are almost uniformly successful, it being infrequent, indeed, that death occurs therefrom in the practice of experienced surgery.

The Modified Incisions.—Modification of the standard incisions of the abdomen are advised for the purpose of meeting the demands of well-understood and of unanticipated conditions that present during the course of the operation. The gridiron method (Fig. 1062) is ideal when the extent of the disease admits of proper treatment. But when for any reason it becomes necessary to enlarge the opening by traction or free division to meet the requirements of proper technique, the muscular structures especially often suffer in an objectionable degree. In such cases additional room can be gained by division upward along the outer border of the rectus muscle (Stimson) of the denser tissues which are united afterward by sewing.

The transverse division of the aponeurosis of the external oblique and the superimposed tissues from a point located half an inch inside of the anterior superior spine of the ilium to the outer border of the rectus muscle is said (Elliot) to afford more room in this method than does the oblique division of these structures. *Weir* gains the needed room by tearing the "denuded fascia" of the external oblique from the sheath of the rectus to near its inner border. He then divides the anterior layer of the sheath transversely to the inner border, draws the rectus muscle inward, ligatures the epigastric vessels as they appear in the sheath, cuts the posterior tissue of the sheath and the peritonæum in a line corresponding to the division of the anterior layer. When the borders of the wound are drawn asunder the pelvic cavity can be freely examined. The tissues of the supplementary incision are repaired in the reverse of the order of division. In other respects the wound is treated as heretofore. This measure affords ample room, with easy and secure repair, and is a valuable adjuvant of the intermuscular separation method.

At about the same time *Battle, Kammerer,* and *Jalaguier* each independently proposed a novel method of approach to the appendix through

the sheath of the rectus in relapsing cases. The anterior walls of the sheath and the superimposed structures are divided vertically at the outer border of the rectus muscle (Figs. 1061 and 1062); the tissues at the inner border of the incision, including the rectus muscle, are drawn inward with blunt retractors (Fig. 1067), thus exposing the posterior wall of the sheath and the semilunar fold of Douglas; through the posterior wall of the sheath, within half an inch of the outer limit (c''), a vertical incision parallel with the preceding one is made into the peritoneal cavity; the borders of this incision are drawn apart, the intestines pushed aside, and the appendix is exposed and removed. The wound is closed in the following manner: The divided borders of the peritonæum, of the fascia, and of the posterior wall of the sheath are united by a single row of continuous or interrupted chromicized catgut sutures. The rectus muscle is then permitted to fall into place and the borders of the anterior layer of the sheath and oblique aponeurosis are joined, as in the preceding instance. The superficial tissues are united with catgut or silkworm-gut sutures. This incision affords a good approach to the pelvis.

Fig. 1067.—Battle-Kammer-er-Jalaguier method. *a.* Posterior layer of sheath of rectus. *b.* Indicating line of superficial external incision (*b* and *b'*, Figs. 1061 and 1062). *c''.* Line of incision through posterior sheath of rectus. *d.* Semilunar fold of Douglas.

The Remarks.—By this method of practice the lines of union of the divided tissues are fortified by the presence and function of the unimpaired rectus muscle and the liability of the occurrence of hernia is correspondingly lessened. However, the degree of exposure to injury of the nerves and the epigastric vessels, and the somewhat limited application of the method, together with the disadvantages incident to the possible needs of drainage, counsel the exercise of wise forethought in its selection. This form of incision is well adapted to children.

In those cases of appendicitis exhibiting evidences of abscess above the crest of the ilium, always suggestive of the presence of a diseaséd appendix behind or to the outer side of the cæcum and colon, an iliac or lumbo-iliac (Grinda) incision may be utilized. In such cases drainage through the loin should be practiced, even in the event of the employment of a standard incision. The great thickness of the abdominal wall at the loin, and the strong tendency of the opening to close, calls for the introduction of a large-sized firm-walled rubber drainage tube.

Vischer's incision is eminently practical in these cases. The external oblique muscle is exposed through a curved incision carried an inch above the crest of the ilium (Fig. 1061, *g*). If additional room is needed, the incision can be extended downward to and along Poupart's ligament. The fibers of the external oblique are separated (Fig. 1062, *g'*), also those of the succeeding muscles down to the fascia, which, along with the peritonæum, are divided vertically, thus promptly reaching the outer aspects of the colon and cæcum. Through this opening the pus will escape, and the appendix

can be removed and dependent drainage through the loin provided. The danger of hernial sequels is not significant. Approach in these cases may be made through the canal of Petit (page 1166).

Meyer advocates an incision which he denominates "the hockey-stick incision." This incision commences at a point half an inch above the imaginary line (Fig. 1061, *a*, *), and at the junction of the outer with the inner three fourths, passes obliquely downward and inward to a point over the femoral artery, and about three quarters of an inch above Poupart's ligament. The tissues are treated as in the intermuscular method, and the abdomen is opened, when, if additional room is needed, the incision can be extended upward and inward, or curved directly inward to a horizontal plane, as circumstances require, thus forming the "hockey-stick" outline (Fig. 1101).

The Remarks.—Ordinarily the horizontal limit of the incision ends at the outer border of the rectus, but, if additional room is required at this aspect of the wound, the rectus can be drawn aside or divided to the needed extent to secure it, after ligature of the epigastric vessels. There is much to be said in favor of this incision when the diseased processes are located low in the iliac fossa and invade the pelvic cavity.

Fowler exposes the aponeurosis of the external oblique by reflecting a triangular-shaped flap of integument and fascia, the upper border extending transversely between the anterior superior spinous process and the rectus abdominis muscle, and the inner from the termination of the former downward, parallel with the edge of the rectus, two and a half inches or more, as circumstances require. Then expose the external oblique still more by counter traction made from the middle of the upper border and at the lower angle; divide the external oblique structure downward and forward about three or more inches to the border of the rectus sheath; make counter traction at right angles with the preceding, thus exposing a greater area of the wound; make a vertical incision into the outer limit of the sheath of the rectus, two or three inches in length; retract the rectus muscle and the epigastric vessels well toward the median line; retract the outer border of the divided aponeurosis in the opposite direction, thus exposing the internal oblique; divide transversely the internal oblique and transversalis muscles in the course of their fibers, extending, if need be, the incision into the posterior wall of the sheath of the rectus; draw asunder the borders of this incision; divide the fascia and peritonæum on the finger from within outward; expose and remove the appendix in the manner fitting the case; replace and unite the deep parts in position with continuous catgut sutures.

The Remarks.—The incised edge of the sheath of the rectus should be carefully closed along with the aponeurosis of the external oblique. No part of the rectus muscle should be included in the sutures. Fowler regards this method as especially applicable to cases with limited impaction. Fowler claims for this method the following:

1. "Ready access is gained to the ileo-cæcal region, and ample room secured for all necessary manipulation in the class of cases for which it is designed.

2. "Weakening of the abdominal wall and the liability to surgical her-

nia are reduced to a minimum by (*a*) incising the important musculo-apo-neurotic structures in such a manner as to secure immediate, firm, and per-manent union; and (*b*) avoiding injury to the vascular and nerve supply of the parts involved in the incisions."

The General Comments.—No one method of operative procedure is equally applicable to all cases. Therefore, a careful consideration of the history and the local manifestations of each case should direct the placing of the primary incision, and thereafter it should be modified to meet the demands of present and final security of the patient. Obese patients, and those affected with disease or subjected to unsanitary surroundings, should be approached surgically with caution when feasible, as these agencies often exercise a potent influence opposed to a favorable outcome. After exposure of the parietal peritonæum through the incision, limited or extended palpa-tion, secured by separation of the peritonæum from the fascia at the sides of the wound, can be practiced to determine the characteristics of the growth. If the stump of the appendix be rigid, it is not advisable to make forcible attempts at invagination, since they will likely fail entirely or lead to deception by their incompleteness. Disappearance of the appendix by maceration in the fluids of the disease is more perplexing than strange, since it may lead to useless and unwise search for the diseased organ. In-asmuch as wide and firm packing of the wound provokes delayed and defective repair, impedes drainage, and favors the formation of constricting bands, the gauze dressing should be placed in the wound in an orderly man-ner and in small amount, so as to encourage drainage and limit as much as possible the production of new tissue. Counter openings for the purpose of the introduction of drainage agents can be wisely employed, when, for any reason, inadequate drainage can not be secured through the primary incision. Extended involvement of the peritoneal cavity and its con-tents suggests the necessity of establishing counter drainage. The admin-istration of constipating agents, and those calculated to disguise important manifestations of disease, especially opium and its derivatives, should be avoided when justifiable. Saline cathartics are advised to secure early action of the bowels and to obviate constipation. The introduction into the small intestine, through an incision or by means of a syringe, of a solu-tion of magnesium sulphate, as advised by *McCosh*, is commendable, espe-cially in septic cases. Avoid eventration, if possible.

The Precautions.—It happens sometimes that the origin of the appen-dix is not associated with the termination of the fibrous bands of the cæcum, a fact that should be recognized, otherwise unfortunate conclusions might follow the absence of the usual relation of these parts. The rolling outward or inward of the cæcum by the contraction of old adhesions often presents to the judgment of the operator annoying anatomical problems. The ligaturing of the appendix outside the seat of the obstruction of the lumen may afford no relief, and even provoke thereafter a renewal of the attack by the establishment of an unventilated mucous chamber at the distal end of the stump. The ascertainment of the permeability of the stump by the introduction through it into the cæcum of a probe, and the stretching of it with forceps before final ligature, are each often of signal importance

in the technique preventive of recurrence. The burial in the wall of the cæcum of an impermeable or diseased stump of the appendix should be avoided for apparent reasons. In raising the appendix into the wound for removal, a small diseased portion of it may be torn away and remain attached by adhesions to a somewhat distant part. The retained fragment may not only become the source of renewed morbid action, but the ruptured appendix may incite inflammation by infection of the serous surfaces along the line of its withdrawal. A careful examination should therefore be made, to determine the integrity of the appendix before the final technique is completed; and, too, caution should be exercised in exposing and raising it upward for removal, to avoid unprepared-for rupture and infection. Chromicized or plain catgut can be employed to tie the stump in all instances; silk can be used in all except the infected cases. The sheath of the rectus abdominis should not be incised when it is practicable to avoid it, for this act may interfere with satisfactory union and repair, and affords opportunity for infiltration of unwholesome fluids along the sheath and muscular fibers; and, too, the branches of the deep epigastric artery would be exposed thereby to untimely injury. If the intestine be adherent to the abdominal wall at the seat of the abdominal incision, great prudence must be exercised to avoid a precipitate or deliberate involvement of the lumen of the gut with the knife. The pinching up of the peritonæum with the thumb and finger, as in hernial protrusions, to determine the presence of adhesions, can be practiced here with excellent result. The trunks of the nerves supplying the abdominal muscles should be carefully looked for and preserved from injury, since their division will cause paralysis and weakening of the part of the abdominal wall to which they are distributed. The placing of a drainage tube in contact with a denuded spot of the intestinal wall is liable to provoke sloughing at that point and cause fæcal fistula. The possibility of the presence of constriction of the bowel at the time of or soon after operation, by old or recent adhesions, should not be disregarded, since the symptoms of this condition may be confounded with those of the primary trouble. All bleeding points should be carefully caught and tied. The writer recalls two instances of secondary hæmorrhages following operation for extensive acute appendicitis, one very annoying, but finally controlled; the other unexpected and fatal because of infection of an extensive subperitoneal extravasation of blood.

The After-treatment.—After the operation the patient is wiped dry, the dressings are applied and confined in place with a broad binder so fastened below as to prevent slipping up and exposing the wound. The patient is then placed in a warm bed, provided with bottles of hot water if needed, and kept quiet. Rarely, indeed, is nourishment given during the first twelve hours, nor soon after this if gastric irritation be noted. In such cases hot water in small amounts may be sipped to quench thirst. Pain, intestinal distention, vomiting, retention of urine, etc., are treated as they arise, avoiding, when possible, the use of opium and its derivatives. The pulse, temperature, and respiration should be taken before the operation and at regular intervals thereafter, so long as the patient remains in bed. Peptonized milk, koumiss, milk and Vichy, and the like, are suitable foods

at the beginning; later more substantial articles can be given. In simple cases the wound is redressed in four or five days, stitches are removed, fresh dressing is applied, and the patient kept quiet in bed for ten or twelve days longer, when he is permitted to rise. If drainage has been employed it should be removed as soon as it has served its purpose. Textile fabric, especially iodoform gauze, when applied for reparative needs, should, after thorough saturation, be removed by twisting on the second or third day. Gentle irrigation or, better still, careful wiping of the cavity is practiced in the instances of the use of drainage for the elimination of inflammatory products and of their objectionable substances. In suppurating cases the patient should remain in bed until substantial healing has taken place. The wearing of an abdominal support for some time thereafter, especially by those exposed to the influences of muscular effort, is a wise provision. It sometimes happens that symptoms indicative of intestinal obstruction, or of extending peritonitis, or localized suppuration, require that the wound be reopened, and perhaps that additional incisions be made, to afford the necessary relief. The raising of the head of the bed in cases of infection should be given consideration (page 748).

Intestinal Perforation in Typhoid Fever.—In 1884 Leyden first proposed operative measures for the relief of this heretofore almost always fatal complication. Since that time 150 cases of operation for its relief have been reported (Keen). The great majority of the perforations occur from the second to the sixth week inclusive, the third (24.8 per cent) and the fourth (21.7 per cent) being the most prolific in this respect (Fitz).

The ileum is the seat of perforation in 81.4 per cent, the large intestine in 12.9 per cent, and the vermiform appendix in 3 per cent of the cases (Fitz). The jejunum and Meckel's diverticulum are perforated in rare instances. The transverse colon suffers least, and the descending colon and sigmoid flexure the most frequently of the subdivisions of the large intestine (Hawkins).

Usually but a single perforation is present, but sometimes several are found, and, besides, points of extreme thinness denoting imminent perforation are often discovered. The perforations vary in size, being in one instance so small as to often baffle detection, in another quite readily discoverable or even distinctly gaping.

The Operation.—The operation should be performed after subsidence of shock and as promptly as is consistent with the welfare of the patient: If the infection be general, as is usually the case, make the primary incision in the median line; if circumscribed, make it over the circumscribed area, therefore, laterally; but in either instance of sufficient size to permit of prompt and free manipulations. When apparent, extravasated contents of the intestine should be removed by careful wiping, aided by a gentle stream of hot saline solution, to avoid a needless spread of infection from handling of the intestines. Usually find the cæcum and begin the search from it.

In the search for the perforation, one is guided by the knowledge of the relative frequency of the seat of the occurrence, and by the local evidences of the inflammation, extravasation, etc. As soon as found, the borders of

the opening and the contiguous thinned surface are turned in without trimming, and united by the mattress suture. If the amount of the inturning be such as to cause too great closure of the bowel, then either enterectomy or enterostomy should be practiced according to the condition of the patient; usually the latter is preferable. Search for a second perforation and for weakened spots in the intestine is required when warranted by the condition of the patient; but, inasmuch as most of the perforations occur within three feet of the ileo-cæcal valve, there is but little that can be gained for the much that may be sacrificed by a larger and more extended examination.

As thorough cleansing as practicable of the peritoneal cavity and of the contents should be employed, either by a systematic wiping with sponges wrung out of a hot saline solution (Finney) or by a careful flushing with this fluid. While in some instances it may be permissible to close the abdomen without drainage, in the majority of cases drainage should be employed. Results are better in drainage without than with wiping.

The ability to determine the presence or absence in the abdominal cavity of infective agents in advance of operation with the view of earlier action, and deciding the question of the employment of drainage, is very important, but will remain for a long time in general practical abeyance in other than hospital practice, because of the practical want of opportunity and the disinclination to carry it into effect in the more common paths of action (see page 749).

The Precautions.—Careful scrutiny, aided by a suitable light, is requisite to the detection of minute or widely separated perforations, and even then, prolonged or vigorous efforts may neutralize the advantages arising from a more discreet course. The mattress suture of Halsted (page 789) is the best that can be employed because of the securer grasp on the softened structures, and of the greater rapidity of its application, especially as relates to tying, since in this variety one knot meets the purposes of two by the interrupted method. It is wise in all cases to examine the appendix, not only because of its occasional involvement in typhoid fever, but also because it alone may be at fault. The employment of local cocain anæsthesia, instead of general anæsthesia, affords the patient the better chance for recovery (see page 121, vol. i).

The Results.—The death rate without operation is fully 95 per cent. In 362 cases operated on, 274 per cent recovered. In operation from eighteen to twenty-five hours after the attack 31.4 per cent recovered; twelve to eighteen hours after, 29.1 per cent; eight to twelve hours after, 26.6 per cent; and during the first eight hours, 10.5 per cent recovered (Keen).

Rapidity of action in this operation influences largely the results. In but one case in which an hour or longer was taken did recovery occur.

Peritonitis dependent on perforation from other than typhoid ulceration is not unusual, and often is entirely unanticipated. Perforation of the intestine, dependent on various morbid processes and on the rupture of the limiting walls of infective accumulations, is often foreshadowed by symptoms peculiar to the nature and location of the causative factors. In such cases the diagnosis of rupture is aided by a knowledge or suspicion of the

existence of the contributing cause.   Serous and connective-tissue invasions differ from each other in symptomatic manifestations.

Generally fatal septic peritonitis is more often the result of such happenings than is the less harmful adhesive variety.   The shock attendant on this class of cases differs in no practical regard from that following typhoid perforations.   However, the degree of pain and the site of the primary manifestations are modified chiefly by the seat of the infection and the nature and the amount of the infecting agents and the tissue involved.

The operative technique differs in no important concern in these cases from that of the typhoid until after the peritonæum is divided.   The examination is then directed to that portion of the abdominal cavity toward which the characteristics of the extravasated fluid, the inflammatory phenomena, and the previous history of the case point.   The removal of the infecting agents (page 745), the search for the perforation, the treatment of the distended intestines (pages 812 and 837), the cleansing and drainage of the peritonæum (page 747), are conducted as promptly and efficiently as circumstances will permit, always remembering that judicious haste is a great *desideratum* in the securing of final recovery.

The Remarks.—The escape of odorless gas and the presence of acid fluid along with gastric contents denote stomach involvement.   If the gas be offensive, or the fluids of a purulent or fæcal character, the portion of the intestine to which they normally belong is likely to be the seat of the opening.   The presence of pus, bile, urine, etc., indicate not only the probable cause of this trouble, but also the source of the fluid.

The elimination from the distended intestines of their objectionable contents by punctures or incisions of the gut is often difficult and perhaps impossible, because of intestinal paralysis and the hindrance arising from the acute flexions of the intestine dependent on a tense mesentery.

The combating of shock by local warmth, hot saline injections, and medicinal stimulation is especially indicated in these cases.   The elimination of the infecting agents that may remain behind in the abdominal cavity is facilitated by the use of saline cathartics and the leaving within the cavity of a portion of the saline fluid (see pages 747 and 121, vol. i).

The Results.—The results of operation for perforations dependent on appendicitis, wounds, etc., are already treated under their proper headings. When arising primarily from unrecognized causes, the death rate varies from 15 to 30 per cent.

Peritonitis due to tuberculosis can be wisely treated in proper cases by abdominal section.   An incision is made usually in the median line, and of sufficient length to permit of easy removal of the fluid by turning the patient on the side or by siphonage.   Wiping of the peritoneal surfaces and free flushing of the abdominal cavity, with saline or other fluids, seems not to be serviceable.   Great care should be exercised to not disturb the intestines.   Incision, evacuation, and prompt closure seems quite as efficient as more rigorous treatment.   In simple cases the abdominal wound is closed promptly, and the patient kept quiet in bed.   In those cases characterized by the presence of pus in the abdomen, or other infective influences, drainage should be practiced from the beginning, while in simpler cases it need

not be employed unless failure of cure follows the safer plan—the imme-
diate closure of the wound, the intestines being disturbed as little as
possible.

   The Remarks.—Abdominal section in the suppurative varieties, espe-
cially if general or in the form of multiple cysts, is very unsatisfactory.
The dry and ulcerating forms of the disease offer indifferent prospects of
success. If permanent drainage be established, continuous care must be
exercised to prevent the subsequent occurrence of infection of the abdomi-
nal cavity. Fæcal fistula may follow rough handling.

   The Results.—In children, in favorable cases, 60 per cent of cures are
reported, with but a trivial mortality from the operation alone. In adults
of the same class of cases, about 38 per cent were cured.

   Operation in the dry and ulcerated forms of the disease is followed by a
death rate of about 75 per cent; in the suppurative multilocular cystic kind
but few recover; in the inflammatory localized suppurative form the opera-
tive outcome is quite favorable.

   Fæcal Fistula and Artificial Anus.—The operative cure of a fæcal fistula
or of an artificial anus is frequently difficult and may be impossible. The
important factors of success in these cases are a sterile wound and proper
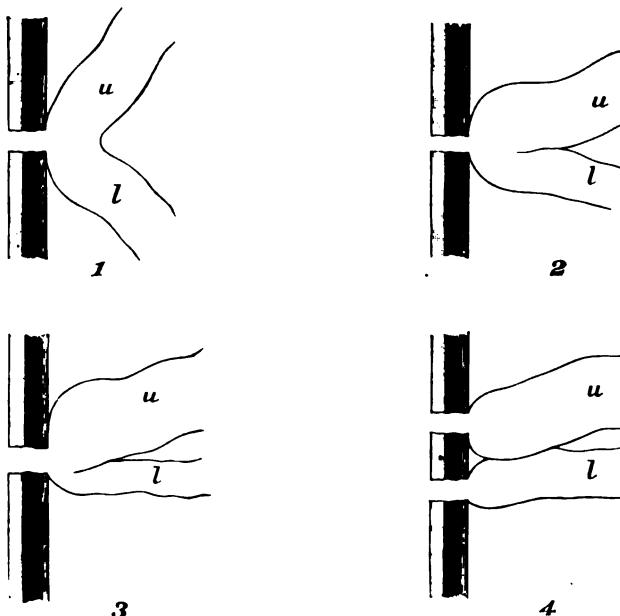
FIG. 1068.—Diagrammatic illustration of fæcal fistula and artificial anus. *u.* Upper
   bowel. *l.* Lower bowel. 1. Fistula without a spur. 2. Fistula with an incom-
   plete spur. 3. False anus with complete spur. 4. Double fæcal fistula.

union of the serous surfaces. The vigorous assaults on these desiderata of
intestinal infection and the effects of previous inflammatory action often
so handicap well-directed surgical efforts as to render the outcome quite

problematical even in apparently simple cases. A long or devious sinus intimately connected with adjacent intestine demands the exercise of the most scrupulous care in its removal to prevent immediate or remote involvement of additional intestine dependent on direct incision, or the sloughing incident to impaired nutrition due to the injury inflicted on the intestinal coats. The removal of the communication with the bowel is a common step in the treatment of these conditions, and is supplemented by either of the following methods of intestinal repair best suited for the case: 1, Simple incision and closure of the opening by sewing; 2, elbowing; 3, enterectomy and direct union by (a) end-to-end sewing; (b) Maunsell's method; (c) Murphy's button; or indirect union by lateral anastomosis in the manner already indicated.

The preparatory treatment of the patient for operation contributes very much indeed to a successful outcome. The intestinal canal should be evacuated thoroughly by saline cathartics, supplemented by copious rectal injections of sterilized water if the colon be the part involved, long enough before the operation to permit of the escape of the fluids from the bowels. The tissues around the opening should be made healthy and the borders be thoroughly cleansed by washing and scrubbing, and softened, too, by emollient applications if unusually hard and rigid. Fluid food alone should be given the patient. *The first step* in the operation relates to the isolation of the sinus leading to the opening in the gut. This step must be carefully practiced to prevent infection of the wound by the agency of the lining membrane of the sinus, and also to avoid injury of intestinal folds lying contiguous to and perhaps intimately connected with it. The removal of the sinus is immediately preceded by scraping and scrubbing of its walls with antiseptic fluid, followed by the passage through it into the intestine of a small sponge retained in place by means of a string attachment,

Fig. 1069.—The treatment of fæcal fistula and artificial anus. *a, a.* Curved incisions. *b, d.* Vertical incisions. *c.* Border of outer wall of fistula.

the free end of which remains without. (The external opening of the sinus is then closed tightly by silk sutures passed somewhat deeply through the borders and tied, the ends remaining uncut. After thorough cleansing of the part the sutures are grasped collectively by means of forcipressure and drawn upward by the surgeon or an assistant so as to elevate the included tissue (Fig. 1069), and an incision an inch or so in length, according to requirements, is made with a sharp scalpel at either side of the elevated end (b, d) in the direction of the long axis of the intestine, if the colon, or vertically if the small intestine be the one involved. The corresponding

extremities of these incisions are then connected with each other by two curved ones (a, a') carried one at either side of the opening about half an inch from the border. The dissection is continued carefully either along the outer (a, a') of these incisions only, or combinedly with one (b) or both (b, d) of the straight incisions outside of the sinus down to the gut, which is then raised up well into the wound. The peritoneal cavity may or may not be involved by the dissection, depending on the extent of the adhesions, the desire to coapt the serous surfaces of the bowel in the repair, or the ignoring entirely of these surfaces followed by the apposition of non-serous structures only in the closure of the opening. The sinus is then removed (Fig. 1070), and if the opening be small the borders are inverted and closed by sewing in the manner already expressed (Figs. 919 and 1155, d). If the peritoneal cavity be not involved, serous tissues are not utilized, and the method of union is indicated in the foregoing illustration (Fig. 1072). If the area of adhesion be unusually limited in extent in this instance, the peritoneal cavity may be involved and serous surfaces are then approximated in the repair. If serous surfaces be desired for repair, the dissection must be extended beyond the limits of the area of adhesion, thus freely opening the peritoneal cavity and calling for a corresponding increase in vigilance. If the intestinal opening be so extensive as to forbid simple closure, "elbowing" (Figs. 1002 and 1003) may be practiced, which calls for peritoneal cavity involvement and serous-surface coaptation. If neither of the preceding plans be prudent, removal of the segment of gut involved in the fistula and the adjacent adhesions should be practiced (enterectomy), and the repair completed by end-to-end union (page 804 et seq.) by the method best intended to meet the demands of the case. *Lateral anastomosis* (page 781 et seq.) may be practiced after enterectomy, if necessary, and even without it in the small intestine by the Murphy button, by sewing, by plates, bone and potato bobbins, etc., thus establishing a short circuit (Fig. 964) and thereby eliminating the loop of intestine involved in the sinus from the line of fæcal flow, which sometimes results in spontaneous cure.

Greig Smith's Method of Treatment.—*Greig Smith* aimed to cure the fistula without peritoneal-cavity involvement. After proper cleansing of the opening and plugging to prevent infection, an incision is made in the direction of the underlying muscular fibers, outward for an inch or two from near the margin of, but not involving, the fistula (Fig. 1069, b, d). The inner end of the incision is carried around the fistula outside the cicatricial border (c), and the dissection is continued carefully downward to the subserous tissue along the entire line of the primary incision (Fig. 1071). The subserous and peritoneal tissues are separated from the super-

FIG. 1070.—The treatment of fæcal fistula and artificial anus. a. Sutures. b. Portion removed. c. Wall of sinus. d. Lumen of sinus.

imposed structures carefully with the finger for two or three inches around the sinus, sufficiently at least to permit the sinus opening, the contiguous intestine, and the parietal peritonæum to be raised well up into the wound. The fistulous tract is removed and the opening closed by the infolding of the freshened surfaces and their union with each other by a primary row of interrupted, and a secondary row of continuous sutures, as in other instances of intestinal sewing. The abdominal wound is then closed in the usual manner. By this method the peritoneal cavity is not involved, the minimum of danger is incurred, and entire dependence is placed on the union of non-serous surfaces. *Smith* gives notable instances of complete success by this plan, and regards the apposition of serous surfaces as not essential to cure. It is apparent at once that the incision can be extended through the peritonæum, so as to utilize the serous surfaces for repair when desired. Senn advises that the fistulous opening be closed tightly by closely
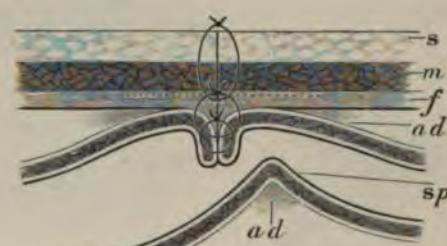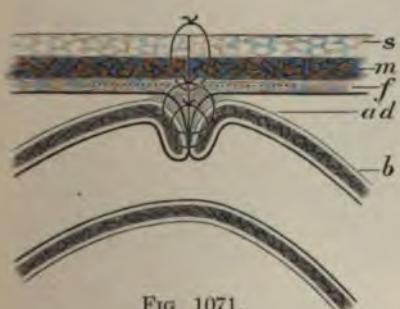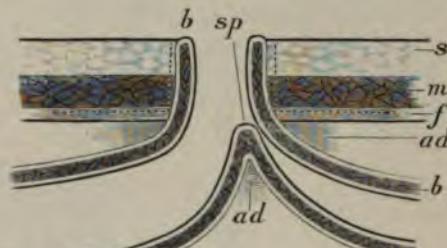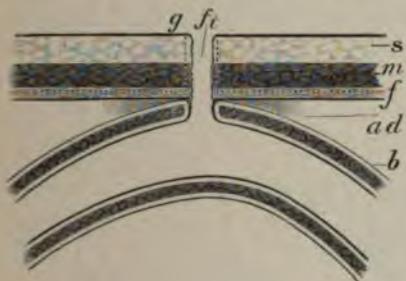
FIG. 1071.   FIG. 1072.

FIG. 1071.—Diagrammatic illustration of closure of fistula, the dissection not involving the peritoneal cavity. *ft.* Fistula. *g.* Granulation lining. *s.* Integument and subcutaneous tissue. *m.* Muscular tissue. *f.* Peritoneal fascia and peritonæum. *ad.* Adhesion between bowel and parietal peritonæum. *b.* Bowel. Dotted line indicates course of incision for removal of sinus. Wound closed with sutures.

FIG. 1072.—Diagrammatic illustration of closure of artificial anus. *ad, ad.* Adhesions between serous surfaces of spur, and between bowel and peritonæum. *b.* Bowel. *f.* Peritonæum and subperitoneal fascia. *m.* Muscular tissue. *s.* Integument and subcutaneous tissue. *sp.* The spur. Dotted line indicates course of incision for removal of fistula. Wound closed with sutures.

applied sutures, instead of by plugging it with cotton or gauze, not only because the former is the more secure, but thereafter the united borders can be turned in and buried by Lembert sutures.

Not infrequently a congestion or spur of the wall of the intestine reaches upward, so as to direct the fæcal flow through the opening (Figs. 1068 and 1076). Sometimes prolapsed mucous membrane of continuous or pedunculated arrangement offers an obstacle to the fæcal flow along the intestine. The ill effects of the spur and the other obstacles should be remedied before the attempt of final closure is made. The spur can be overcome wholly or in part by the introduction into the intestine of a large-sized piece of rubber tubing so placed as to depress the spur. The tubing is held in position by fine silver wire, or by a string passed through the wall but not into the lumen of the tube, and fastened securely on the outer surface of the abdomen (Fig. 1073). Inasmuch as *Senn* regards flexion of the bowel as the prime cause of the spur, he advises that the opening be closed by sewing transversely instead of longitudinally as is the common practice. The pedunculated mucous structures can be drawn up and tied off with fine silk if their attachments be small. The author in one instance removed a spur in ten days without trouble by the application to it through the opening in the bowel of a small-sized Murphy button. *Robson* cured a fæcal fistula complicated with stricture of the intestine by exposing and dividing the stricture in the long axis of the intestine, followed by the introduction of a

FIG. 1073. Overcoming spur by rubber tube. Tube held in place by string or by wire.

decalcified bone bobbin into the lumen and its confinement in place by closure over it of the denuded tissue by transverse suturing. The mucous margins were united by a continuous catgut, and the serous by a silk, suture. The patient made a prompt and uneventful recovery, and has remained well since that time.

Instrumental methods of removal of the spur, with a view of curing a fistulous opening, are among the oldest of practice. At the present time much less notice is given them than formerly. The enterotomes of Dupuytren, Collin, etc. (Fig. 1074), are well-known instruments. The enterotome devised by Gross is better than either of the preceding, because it not only

divides but removes the spur (Fig. 1077). The method of Bodine (page 827), directed both to the formation and removal of the spur, is the latest and best of the series.

The Remarks.—The enterotome should be so applied as not to open into the peritoneal cavity, and should remain from one to two weeks, or until liberated by necrosis of the included tissues. Only sufficient of the spur should be grasped to effect the removal of the requisite amount, thereby limiting the danger of perforation and the possibility of including in the grasp of the instrument a nearby intestinal loop.

The Results.—The tendency to abandonment of this somewhat crude method of practice is not yet justifiable, especially since it is evident that the death rate attending it (8 to 9 per cent) is nearly 16 per cent less than that of resection of the bowel for cure. Sixty per cent are cured by the method, and quite 30 per cent much relieved.

Fig. 1074.—The enterotomes. *a.* Dupuytren's enterotome. *b.* Collin's enterotome.

The General Remarks.—If the peritoneal cavity be involved in the operation, failure of union of the intestinal opening is exceedingly dangerous, especially if the abdominal wound has been closed. Therefore, if there be reason to regard union as at all problematical, the abdominal wound ought

Fig. 1075.   Fig. 1076.   Fig. 1077.

Fig. 1075.—Artificial anus without a spur. The intestine is partially opened in the vicinity of the artificial anus.

Fig. 1076.—Artificial anus with spur. The afferent and efferent portions of the bowel are partially opened.

Fig. 1077.—The destruction of spur by enterotome. Anterior wall of the intestine cut away to show better the position of enterotome.

not to be closed entirely, and the field of repair should be carefully isolated from the peritoneal cavity by strips of iodoform gauze. If the colon be the intestine involved, lateral approximation (if practicable) is the best

method, for then serous surfaces only will be in juxtaposition. End-to-end union with the large Murphy button or by Maunsell's method comes next in order of efficiency in the majority of instances. Direct enterorrhaphy is less promptly done, because the exercise of vigilant care is required for a safe union of the borders of gut not covered with serous membrane, and defective repair will invite prompt and fatal disaster. In case of closure of intestinal openings with uncertain outcome, it is wiser to invert the edges without trimming, since in the case of failure the opening would not be increased in size. The introduction into the fistulous tract of a catheter, large probe, gauze packing, etc., to better define the outline during the removal, is a commendable procedure. *R. Morris* advises the employment of plaster of Paris for the purpose, introduced in a plastic condition. Paraffin also fills the inequalities of the tract, and when hardened enables the surgeon to estimate its limits better than by any other means. Transverse sewing of the opening should be employed if possible, in lieu of the longitudinal variety, when the latter reduces unduly the lumen of the gut. The detachment of the parietal peritonæum in this operation should commence at the distal ends of the incision instead of close to the border of the fistula, thus reducing the liability of opening the peritoneal cavity to a minimum. The divided tissues of the abdominal wall should be closely apposed by sutures to eliminate the occurrence of dead spaces. The presence in the bowel of the rubber tube—for the purpose of lessening the spur (Fig. 1073), and perhaps sufficiently diminishing its obstructive influence to effect a cure—is attended not infrequently by a marked irritation which, on removal of the agent for two or three days, quickly subsides.

The After-treatment.—As fluid food only is given for two or three days before operation, the continuance of the same thereafter for a brief period is a valuable element of treatment. The patient is kept quiet and the wound carefully observed after the third day for the presence of manifestations of failure of repair in order to anticipate the possibility of the occurrence of fæcal extravasation.

The Results.—Failure of the attempt at closure of fistulæ is not infrequent, consequently an indulgence in glowing prognosis should be avoided. The death rate in simple cases should be insignificant if the aseptic and other technique be supplemented with proper post-operative vigilance. *Makins* reports a death rate of 38.4 per cent from thirty-nine cases of resection for the cure of fæcal fistula. About 10 per cent less than the above now conforms more nearly to the operative results.

The operations connecting the intestine with the stomach (*gastro-enterostomy*), with the gall bladder (*cholecystenterostomy*), with the ureter (*uretero-enterostomy*), etc., are noted elsewhere under more significant headings.

THE OPERATIONS ON THE STOMACH.

It is necessary sometimes to open the stomach to remove foreign bodies, to supply nutrition, to overcome œsophageal obstruction, or to remedy the various other conditions of a surgical nature that are amenable to interference through direct incision of the stomach. In each instance the open-

ing in the abdomen and the viscus is made as small as may be consistent
with the proper operative technique. It follows, therefore, that the digital
sense is of great practical utility in the determinative and diagnostic ele-
ments of the procedure. The finger should be educated, by repeated lessons
on the dead subject, to recognize the individual characteristics of the re-
spective tissues involved in the operation, their relations with each other,
and the presence of tangible evidences of disease complications, without
unnecessary delay or harmful manipulation.

The Anatomical Points.—Whether or not the stomach be collapsed or
distended, or be influenced by the respiratory acts or the effects of disease,
determines very largely, indeed, its relations with the associated organs and
tissues. When empty it lies posteriorly and beneath the liver and at a con-
siderable distance from the abdominal wall in front, and upon the trans-
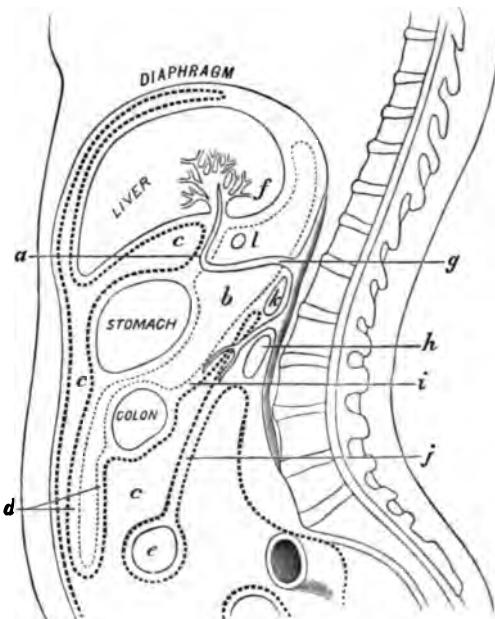
Fig. 1078.—The relations of the stomach, etc., to the peritonæum and contiguous organs.
a. Gastrohepatic or lesser omentum. *b.* Lesser peritoneal cavity. *c.* Greater
peritoneal cavity. *d.* Folds of great omentum. *e.* Small intestines. *f.* Liver.
g. Cœliac axis. *h.* Duodenum. *i.* Transverse mesocolon. *j* Mesentery. *k.* Pan-
creas. *l.* Foramen of Winslow.

verse mesocolon, which separates it from the pancreas, the large abdominal
vessels, and the solar plexus (Fig. 1078). With increasing distention the
anterior wall looks upward, the posterior downward, and finally the former
rests against the abdominal wall in front. In the normal state the cardiac
orifice is close to a point beneath the chondro-sternal junction of the left sev-
enth rib. An empty pylorus lies about three inches below this articulation
and at the right of the linea alba; when distended it is two or three inches
farther to the right. A triangle formed at the right by the edge of the nor-

61

mal liver, at the left by the free borders of the eighth and ninth costal carti-
lages, with its base at a line extending between the tips of the tenth costal
cartilages, corresponds to the surface of a moderately distended stomach
lying immediately beneath the abdominal wall, at which time the greater
curvature lies quite near to the transverse colon, and each has been mistaken
for the other in operative practice (Fig. 1080). The position of the stom-
ach is changed by respiration, descending with the inspiratory, and ascend-
ing with the expiratory, act.

The identity of the stomach is established by its immediate relation
with the under surface of the liver and the continuity with the anterior
layer of the gastro hepatic omentum; by its broad, smooth surface, pale
color, dense structure, and the characteristic arrangement of the vascular
supply. It is placed obliquely, running downward from left to right in the
adult, and almost vertically in early life.

Gastrotomy. The operation of gastrotomy contemplates the temporary
opening of the stomach for the removal of foreign bodies, for pyloric and
œsophageal exploration, and for other measures intended to determine the
presence of pathological states that may be amenable to prompt surgical
remedy.

The Preparatory Treatment.--The general condition of the patient
should first be fitted for the operation by the employment of remedies,
when the benefit to be gained thereby is regarded an adequate recompense
for the delay in operative procedure. Usually, however, the effects of pro-
crastination are so well marked already when the patient comes under the
observation of the surgeon, as to demand prompt action if a favorable out-
come is to be expected. If there be no obstacle to the measure, the stomach
should be thoroughly washed out with a solution of bicarbonate of soda
before the operation. If the organ be small, it may be deemed advisable to
allow five or six ounces of the fluid to remain, that the location of the stom-
ach may be the more readily determined. However, the employment of
distending measures of any kind are not now regarded as essential or even
wise, except in special cases, as they may prove obstructive and even disas-
trous if the peritoneal cavity be infected by their incontinent escape. The
intestinal tract should be thoroughly cleansed, especially the large intestine,
to fit it the better to retain nutritive enemata. Strict asepsis should be
exercised in connection with every detail of the operation (see page 740).

Chloroform anæsthesia, because it is followed by nausea and vomiting
less frequently than ether, is preferable in operative surgery of the stomach,
unless special objection to its use be present. After proper anæsthesia,
the patient is placed on the back with the legs extended. The operation
field is prepared after the manner before stated (page 740 *et seq.*). Local
anæsthesia from cocain should be used instead of general anæsthesia when
haste or great prostration forbid the employment of the latter.

The Operation of Gastrotomy.—Make an incision two or three inches
in length in the median line over the stomach down to the peritonæum
(Fig. 1101); arrest hæmorrhage, then divide the peritonæum to nearly the
extent of the primary incision; grasp the borders of this membrane, draw
them slightly upward and transfix each border of the wound through the

entire thickness with a curved needle armed with a long traction suture; tie a single fold in each suture, thus drawing the respective tissues of each
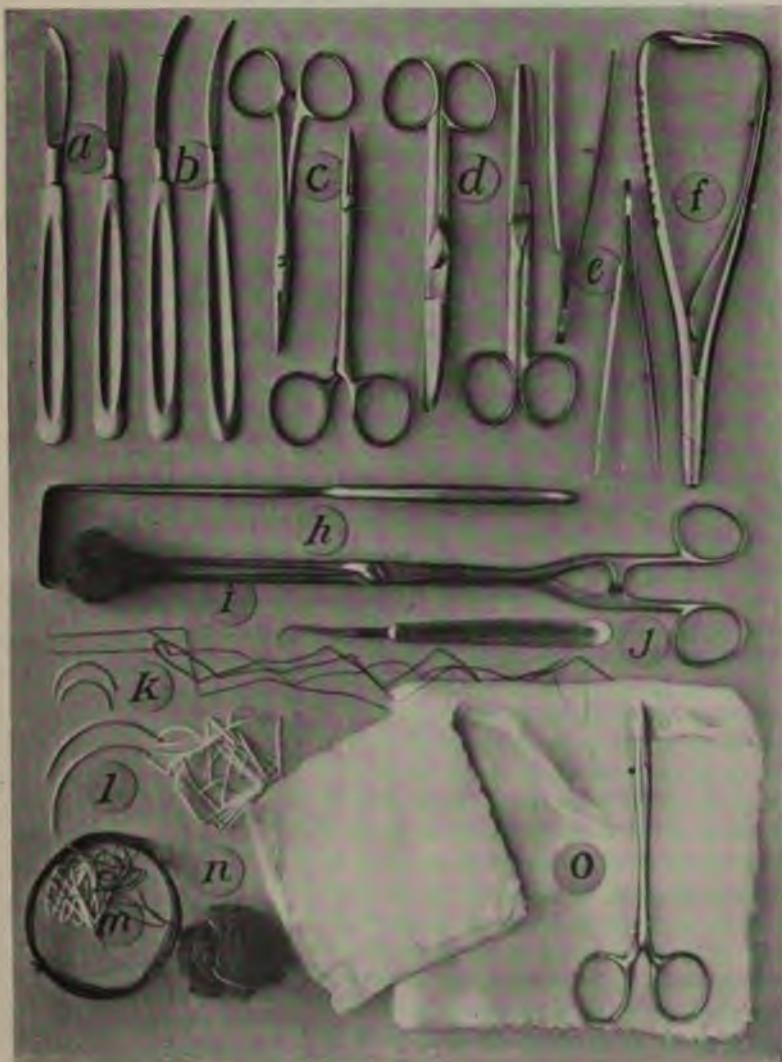
FIG. 1079.—Instruments employed in gastrotomy and gastrostomy.

a. Scalpels.   *b.* Bistouries.   *c.* Forcipressure.   *d.* Curved and straight scissors.   *e.* Thumb forceps.   *f.* Needle-holder.   *h.* Retractor.   *i.* Sponge-holder.   *j.* Tenaculum.   *k.* Round straight needles armed with black silk, also curved needles.   *l.* Traction loops.   *m.* Silk and catgut sutures.   *n.* Sponge with string attachment. *o.* Large and small gauze pads with tape attachments and forcipressure anchor of pad.   Perforated rubber dam for isolation is employed (Turck).

border of the wound in contact with each other; seize the ends of each suture independently with a forcipressure, or form a loop of each by tying

the extremities together; pull apart the borders of the wound by means of the traction sutures; introduce the index finger and thumb of the right hand into the wound and pass them backward along the under surface of the liver to the gastro-hepatic omentum (Fig. 1078); depress the hand, thus bringing the thumb and finger in contact with the upper surface of the stomach, which is recognized by the broad, smooth surface and its contiguity to the liver (Fig. 1080); seize the viscus near the lower border with the thumb and fingers and draw the anterior wall well up into the wound; make sure that the stomach has been seized, by ocular examination. Cause the assistant to seize the stomach at either side of the abdominal wound with the thumbs and fingers; carefully introduce between the protrusion and the borders of the abdominal wound wipers to which long strings are tied for identification; supplement gauze pads with aseptic gauze, wet with saline solution if advisable; pass a traction suture of silkworm gut deeply into the wall of the stomach at either side of the line of proposed incision; make an opening two inches in length into the stomach in the vertical axis parallel with the vessels (Fig. 1080); raise the opening still farther upward by means of the traction sutures, aided by small retractors if necessary, and arrest hæmorrhage. If the stomach have not been washed out and the need for it be present, turn the patient carefully to the right side so as to allow the contents to escape, directing them away from the patient by oiled silk or abundant gauze. Finally, flush the stomach with hot sterilized water or a bicarbonate-of-soda solution, if requisite for further cleanliness or better technique. Carefully cleanse the parts and draw the lips of the incision in the stomach together by crossing the traction sutures; renew the pads and gauze packing if need be, and return the patient to the dorsal position. Introduce the index finger carefully into the stomach and search for and locate the cause demanding the operation, enlarging the gastric wound sufficiently to admit the thumb and even the entire hand if needful for complete examination.

The Remarks.—If the exploration be for the purpose of overcoming obstruction at the pyloric or the cardiac orifice, or for the removal of a foreign body by way of either of these openings, or from the stomach itself, the steps necessary for the attainment of the object are carried into effect with caution, to avoid needless injury of the viscus and of the borders of the wound. Therefore, the location of the abdominal incision should be varied to conform with the requirements of the case. As, if examination of the cardiac opening of the œsophagus (page 672, vol. i) or the cardiac end of the stomach be intended, the primary incision should be made in the same direction but somewhat farther from the ribs than for gastrostomy. The pyloric opening and other portions than the cardiac can be properly approached through the median incision already described. Large, fixed, and rigid foreign bodies discernible by external manipulation, or by the X rays, are often better removed through an external incision made directly upon them than through either of those just described. If a foreign body be present, it should be sought for first at the pyloric end of the organ, owing to its dependent position, and, when located, seized with forceps and removed cautiously with due respect for the injury it may inflict on with-

drawal. It is better practice to increase the size of the stomach incision so as to allow easy removal than to bruise the tissues by forced action. In the examination for disease of the stomach, the borders of the wound should be opened widely by the traction sutures and retractors, after which the walls of the cavity of the viscus can be readily inspected in detail when separated by small sponges on holders, aided by a strong concentrated light (Fig. 999, *o*). The wound in the stomach is closed by sewing together the mucous borders with a continuous fine silk suture, followed by union of the remaining coats with interrupted or continuous sutures of similar material. After thorough cleansing with the saline solution, the traction sutures are removed and the stomach is allowed to fall back into place. The abdominal wound is then closed by means of tier suturing (Fig. 905) or otherwise. Incisions for exposing the stomach should not be vertical throughout, except when made in the median line, for when vertical incisions are located elsewhere the abdominal nerves are divided, and this is followed by loss of power of the muscular structures to which they are distributed.

The After-treatment.—The patient should be kept quiet and sustained by nutrient enemata for the first few hours. Light fluid food is then given in small amounts at frequent intervals for two or three days, followed soon by simple though easily digestible food of a more substantial nature.

The Results.—About 20 per cent die from the operation of gastrotomy. The conditions demanding the operation contribute much more to the fatal results than does the operation itself, from which but little danger need come.

Gastrostomy.—The operation of gastrostomy signifies the establishment of a fistula leading from the stomach to the external world for the purpose of preventing starvation. Gastrostomy is practiced with strict aseptic precautions. The employment of nutritive, stimulating enemata should precede the performance of the operation. Too often the favorable opportunities afforded by surgical intervention in these cases have been greatly impaired or apparently already sacrificed by irrational delay before the surgeon is consulted. In such cases as these complicated surgical effort under general anæsthesia is quite surely fatal. Therefore, local anæsthesia, attended by simple operative practice, should be employed, or tubage (page 677, vol. i) utilized instead, as may seem wisest at the time. In any event, local warmth should be provided and general stimulation practiced before the operation is commenced (page 120, vol. i). The instruments required differ in no special regard from those for gastrotomy (Fig. 1079).

Stages of the Operation.—The operation may be completed at one sitting or divided into two stages (Howse), according to the nutritive demands of the case or the special method of procedure adopted. In either instance it can be divided into the following steps: 1, The locating and making of the abdominal incision; 2, the exposing and drawing into the abdominal wound of the requisite portion of the stomach; 3, the fixation and opening of the stomach.

The First Step (Locating and Making Abdominal Incision).—Locate the free margin of the liver and the costal cartilages of the eighth and ninth ribs on the left side; make an oblique incision two inches and a half in

61*

length with the center an inch below the free margin of the liver (Fig. 1101) parallel with and an inch and a half inside the borders of the costal cartilages of the eight and ninth ribs down to the external oblique muscle (Fig. 1080); divide the fibers of the external oblique, separate those of the internal and hold them apart with blunt retractors; divide the fibers of the transversalis muscle, thus reaching the transversalis and subserous fasciæ,
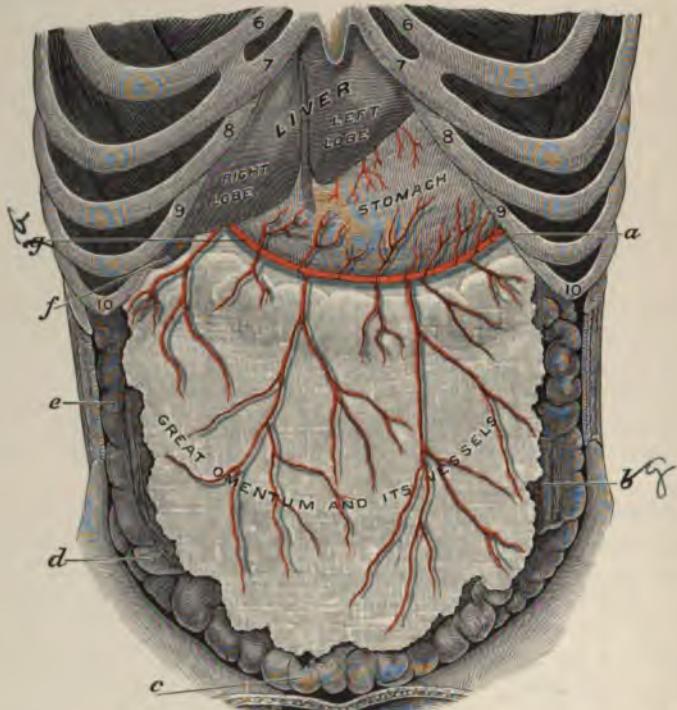
FIG. 1080.—The anterior surface of the stomach, showing its relation to the liver, the transverse colon, the great omentum, and the cartilages of the ribs. *a*. Gastro-epiploica sinestra artery. *b*. Gastro-epiploica dextra artery. *c*. Small intestines. *d*. Cæcum. *e*. Ascending colon. *f*. Gall bladder. *g*. Sigmoid flexure.

which are then likewise cut. Arrest hæmorrhage, pick up the peritonæum with forceps, and carefully divide it to an extent similar to that of the other tissues. Introduce traction sutures entirely through each border of the wound, and tie and loop as before described (page 741).

The Remarks.—Since this class of patients is usually very much emaciated, the tissues to be divided are naturally inclined inward and downward from the free borders of the cartilages of the ribs, therefore the edge of the knife should be turned backward and a little outward at a right angle with the surface to secure a proper division of the respective structures. This incision sometimes involves the sheath of the rectus muscle and perhaps muscle itself. In the latter instance the fibers can be cut or pulled

aside as seems best at the time. *Jacobson* prefers a vertical incision made from a point opposite the inner end of the eighth intercostal space (Fig. 1101) downward for three inches parallel with and about two inches to the outer side of the linea alba. The fibers of the rectus abdominis are exposed and separated without division, the posterior layer of the sheath is divided vertically, the borders of the wound are separated and the fasciæ and peritonæum divided as before.

The Second Step (Exposing and Drawing Part of Stomach into Wound).—Draw apart the borders of the wound with the traction sutures, aided by blunt retractors if necessary, bringing the lower border of the liver, and perhaps the stomach, into view; pass the index finger backward along the under surface of the liver to define the stomach, if not already apparent; seize and draw the stomach forward and locate the best point for the opening. In determining this fact, remember that the opening should be located as near to the greater curvature and the cardiac end as is possible consistent with the integrity of the vascular supply (Fig. 1132). Entire freedom from needless traction on the organ after its union with the abdominal wall should also be secured. Having fixed on the point of opening, seize the wall at that point with forceps, and draw into the wound the necessary amount of the viscus to conform to the requirements of the method of operation adopted.

The Remarks.—The stomach may be mistaken for the transverse colon (Fig. 1080), especially when the former is much contracted, or when the latter promptly presents at the wound. However, the differences in the color, density, smoothness, omental connections and relations with the liver, should promptly prevent the possibility of error in this respect. Often the great omentum will appear at the wound, and especially if the colon be drawn upward by retraction of the stomach or the manipulations of the operator. If the stomach be unusually small, or have become contracted from the effects of disease, or be adherent posteriorly, much difficulty may be experienced in properly connecting it with the external opening. As soon as the abdomen is opened, the entrance of air often causes abdominal distention and also the retreat of the stomach backward beneath the liver, thus adding an impediment to the bringing forward of the viscus.

The Third Step (Fixation and Opening of the Stomach).—Draw the stomach forward into the wound sufficiently to form a neck at that situation of about three fourths of an inch in diameter; transfix the extremities of the abdominal wound with silkworm-gut sutures carried through the whole thickness of the abdominal wall; unite the neck of the protrusion with the borders of the abdominal wound by means of several silkworm-gut sutures carried through the serous and muscular coats of the former, thence outward through the entire thickness of the abdominal wound, by a curved needle; pass a guiding suture through the apex of the protrusion, tie the sutures at either end of the wound, thus fixing the protrusion in a secure position; dust the wound and the protrusion with iodoform, apply protective dressings, put the patient in bed, providing for comfort and proper nutrition, thus ending the technique of *the first stage* if the operation is to be thus divided. If not, an opening is made into the stomach at once

instead of after two or three days' delay, remembering that if the opening be made too near the pyloric end of the stomach, regurgitation of food may result.

The Remarks.—Additional security is gained by the use of fine sutures between the preceding ones, uniting the wall of the protrusion and the border of the wound with each other somewhat superficially. If time will permit, the outer coat of the protrusion can be united by means of a primary row of continuous or interrupted silk or catgut sutures with the borders of the divided peritonæum. However, here as elsewhere, about the abdominal cavity, the parts when thus arranged in the opening are less securely fixed than when joined directly with the borders of the wound. The modified suture of *Howse* is regarded by Greig Smith as being the most secure for the purpose (Fig. 1081). It is applied as follows: Introduce
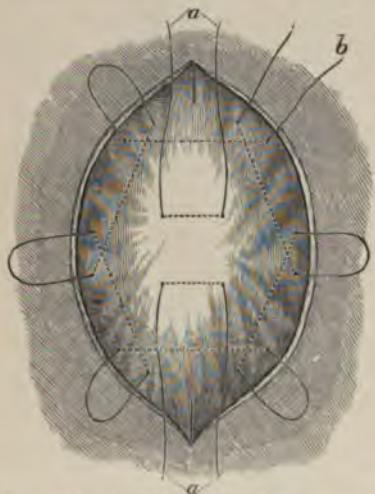
Fig. 1081.—The fixation of the stomach in gastrostomy, Howse's method, first step.
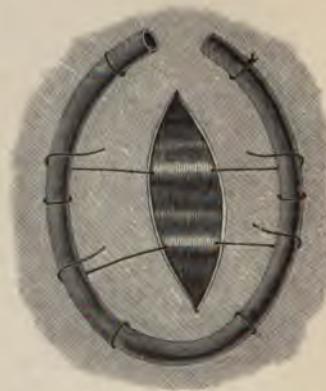
Fig. 1082.—The fixation of the stomach in gastrostomy, Howse's method, fixation completed.

two silver-wire loops near the site of the proposed opening (*a, a*) in the stomach, to afford ease in manipulation of it during sewing; convey a needle armed with a soft silk suture (*b*) about a foot in length around the base of the protrusion beneath its serous and muscular coats, inserting it and causing it to emerge successively so as to form loops about an inch and a half in length, situated at about half-inch intervals, until six or eight loops are made, taking care to cause a crossing of the suture at the base of each loop, as indicated in the illustration. Then transfix the border of the wound at sites opposite to the loops with hooked needles, by means of which the loops are drawn through the skin and are then fastened in place by rubber tubing slipped beneath them. Fix the loops firmly to the tubing by drawing upon and tying the loose ends of the suture; bend the ends of the silver wire around the tubing, thus holding the stomach upward into the wound (Fig. 1082). Harelip pins, long needles, and temporary sutures of silkworm gut can also be used for the purpose.

The latter part of the third step—opening the stomach—can be practiced at once, or deferred (*second stage*), according to the demands of the case. In either instance the point for opening is raised up by means of the guiding sutures or the forceps, and an incision large enough to admit snugly a rubber tube of the size of a No. 8 or No. 10 Eng. catheter is made into the stomach with the end of a sharp-pointed bistoury. The tube should be freely flexible, about eighteen inches in length, and provided with a small funnel for feeding the patient. The cautery is sometimes employed in opening the stomach, but has nothing to commend it except the prevention of hæmorrhage, which, with proper care, is so insignificant and so readily arrested as not to be of serious import.

The Remarks.—If the making of the opening be deferred for four or five days, firm adhesions will have taken place between the stomach and borders of the wound, and leakage into the peritoneal cavity need not be regarded as possible. A troublesome cough is a contraindication to the operation.

The After-treatment.—The character, amount, and plan of administration of nutrition by the rubber tube differs in no essential regard, after a little time, from that by means of the normal œsophageal tube, except that the quantities introduced are smaller, more finely divided, and more frequently given for obvious physiological reasons. Koumiss, peptonized milk,

Fig. 1083.—Patient feeding himself through a gastric fistula.

with eggs, brandy, etc., can be given at first frequently and in small amounts (half an ounce or so), and gradually increased as the case progresses. The mastication of food by the patient before its discharge through the tube into the stomach adds to the act the pleasure of gustation and to the food the digestive influence of the saliva (Fig. 1083), and reflexedly stimulates the gastric secretions.

The Precautions.—The food should be strained to prevent blocking the tube, and be given at the temperature of the body. If regurgitation happen the patient should lie on the back during the administration of food. In the interim of feeding, the tube is fastened against the abdomen in the form of a coil, with the open end surrounded with absorbent gauze to permit the ready escape of the fluids and gases through the tube, when necessary, rather than through the opening by the side of the tube. The tube should be kept clean and changed often enough to preserve its sanitary condition and structural integrity. The free use of vaseline after washing the surface of the abdomen with lime-water and aseptic solutions will reduce the annoyance from contact with gastric fluids to a minimum. The opening of an established fistula is closed with a pad of non-absorptive material after removal of the tube in feeding.

The Results.—According to Gross, the rate of mortality as based on 207 cases is 29.47 per cent. In 162 cases Zesos estimated it at 60 per cent in cicatricial and 84 per cent in malignant stenosis. When it is considered that the latter observer dealt with cases treated under antiseptic technique, it is apparent that a fallacy in reasoning exists in one or the other conclusions of these surgeons. Later estimates place the rate of mortality at about 28 per cent in malignant cases, and at about 19 per cent in non-malignant.

Witzel's Method.—Witzel's method is one especially directed to the establishment of a canal or pseudo-œsophagus along the wall of the stomach, which is much better suited to prevent the escape of the contents of the stomach through the abdominal opening than is the preceding method.

The abdominal incision is made at the left side and at the place best suited to the practice of the surgeon or the demands of the case. Usually it is made about three inches in length, beginning near the median line and passing obliquely downward and outward across the rectus abdominis parallel with and an inch to an inch and a half below the border of the costal cartilages (Fig. 1101). The muscular fibers of the rectus abdominis are differently treated in the course of the incision. They can be divided obliquely, separated vertically (Von Hacker), or folds of muscle can be caused to cross each other from either side of the line of separation between which the wall of the stomach is drawn up (Girard). In the last two examples the formation of a sphincter to control the opening is aimed at, and in the majority of instances with beneficial results. The stomach is drawn into the wound sufficiently to permit full scope for the necessary manipulations, and the borders of the wound are packed with gauze. A small opening is then made into the stomach, directed toward the cardiac end, of sufficient size to admit somewhat snugly the end of a rubber tube (size 25 French), of which about an inch is introduced and the external portion is pressed upward against the stomach parallel with the borders of the abdominal incision, and wrapped in for two or three inches of its length by uniting the walls of the stomach over it with several silk Lembert sutures, fortified, if need be, by a continuous row thereafter (Figs. 1084 and 1085). The stomach is allowed to retreat sufficiently to permit the entire operation field to present at the wound, when its borders are closely united to the perito-

næum and posterior layer of the sheath of the rectus by interrupted silk sutures (Fig. 1086). The abdominal wound is then completely united by interrupted silkworm-gut sutures, and the tube, closed above by tying, or by a rubber band (Fig. 1087), is fastened in position by a stitch. The tube
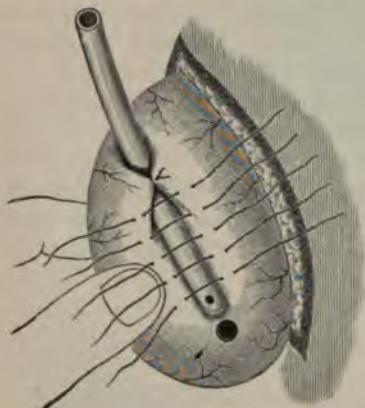
FIG. 1084.

FIG. 1085.
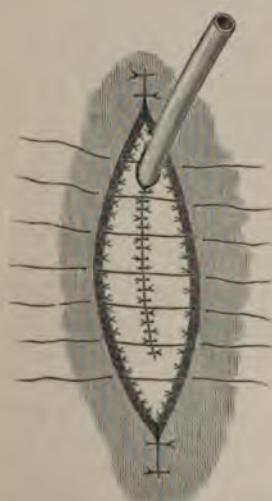
FIG. 1086.

FIG. 1087.

FIG. 1088.

FIG. 1084.—Witzel's method of gastrostomy, wrapping in the tube.

FIG. 1085.—Witzel's method of gastrostomy, the tube wrapped in.

FIG. 1086.—Witzel's method of gastrostomy, the stomach sutured in place and sutures laid to close the abdominal wound.

FIG. 1087.—Witzel's method of gastrostomy, the abdominal wound closed and the tube constricted above.

FIG. 1088.—Witzel's method of gastrostomy, a longitudinal view explaining the relation of the tube to the arrangement of the parts.

is kept in place for three or four days until firm adhesions have ensued, the patient being nourished with nutritive enemata. After this time the pa-

tient is fed through the tube, which is at first introduced at frequent intervals to prevent undue closure of the opening. Later, however, the tube is employed only for the purpose of feeding; unless, as sometimes happens, the difficulty of reintroduction (Fig. 1088) makes necessary permanent retention.

The Results.—While the special benefits attributed to this method are not always realized, still, the outcome compares favorably with that of other measures.

Ssabanejew-Franck Method.—*Kocher* credits Albert with this method, and regards it as being "the simplest and most reliable" one as modified by himself. Kocher carries the abdominal incision downward and outward
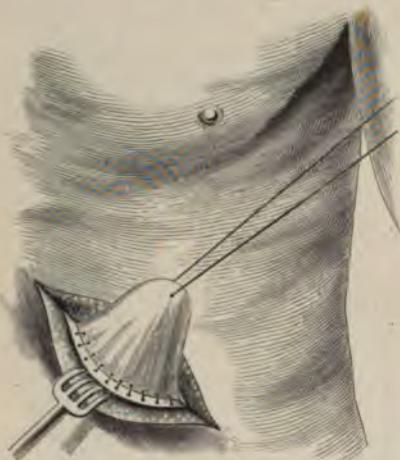
FIG. 1089.   FIG. 1090.

FIG. 1089.—Ssabanejew-Franck method of gastrostomy, stomach drawn into the wound and sutured in place.

FIG. 1090.—Ssabanejew-Franck method of gastrostomy, the lower wound closed and the borders of the opening stitched to those of the upper incision.

over the rectus muscle—more vertically than horizontally—about two inches from the margin of the costal cartilages; the muscular fibers of the rectus are separated vertically at the inner edge of the wound and drawn apart; the posterior wall of the sheath of the rectus and the peritonæum are divided, a long conical process of the stomach is drawn into the wound, and its base is united without much constriction to the deep borders of the wound by continuous or interrupted sutures, which include the serous and muscular coats of the stomach on the one side and the peritonæum and posterior part of the sheath of the rectus, on the other (Fig. 1089). The founders of the method made the primary incision more oblique, and divided in the same direction fibers of the rectus muscle instead of separating them. A small incision is then made through the skin about an inch above the cartilages of the ribs, the intervening bridge of skin is undermined, and the apex of the diverticulum of the stomach is drawn upward under the skin and over the lower costal cartilages as far as the small skin incision, to the

edges of which the apex is fastened by sutures (Fig. 1090). A small opening is made at once into the apex of the protrusion, additional sutures are introduced at the borders, and the lower wound is closed with a continuous or interrupted suture.

The Remarks.—The success of this plan requires that the stomach be lax, and therefore not contracted or adherent, as it is liable to be from the effects of the various causes that demand gastrostomy, and, as sometimes happens, from prolonged starvation. The permanency of the fistula formed by this method contraindicates its employment in cases of œsophageal or gastric disease amenable to cure. This method of practice is hardly possible unless at least an inch and a half of the wall of the stomach can be drawn through the wound (Keen). The bending upward of the diverticulum and the grasping of its base by the separated fibers of the rectus muscle (Fischer) prevents the escape of fluids from the stomach and offers no obstacle to their introduction with a catheter.

Hahn's Modification.—*Hahn* gained access to the stomach by means of Fenger's incision, which is made about three inches in length and located to the left of the sheath of the rectus muscle, parallel with and about an inch below the costal cartilage (Fig. 1101). He then made a superior incision through the eighth intercostal space close to the cartilages, perforated the intervening tissues with sharp-pointed hæmostatic forceps guided by the finger in the lower wound, seized the wall of the stomach with the forceps, drew it into the upper incision, joined the apex to the skin with sutures, and then finally closed the lower opening in the usual way.

The Remarks.—Hahn's modification offers no especial practical advantages to compensate for the increased danger attending its employment. The pleural cavity may be involved, and the efforts to obviate this danger may lead to injury of the cartilages and their subsequent necrosis. There is no reason to believe that the restraining influences of the cartilages are superior to the tissues utilized in other and safer plans of practice.

Senn's (E. J.) Method.—The basis principle of action of this method is the formation from the walls of the stomach of a circular valvelike structure near the surface, which readily permits of the introduction of food, yet aims to prevent the escape of fluid at all times.

The Operation.—Make the abdominal incision at the most desirable situation irrespective of the muscular structures, as their action is not needed in this method; grasp the anterior surface of the stomach near the greater curvature with the fingers or a suitable forceps, and draw a cone-shaped portion well upward into the opening, giving it in charge of an assistant; introduce, so as to include the serous and muscular coats of the stomach, two and a half inches below the apex of the cone, two purse-string sutures of chromicized catgut (Fig. 1091); draw them tightly, thus forming a neck (Fig. 1092); raise up a portion of the gastrocolic omentum and suture it in a cufflike manner around the constriction with silk (Fig. 1093); suture the stomach in place with silk so as to include its serous and muscular coats, the upper portion of the omental cuff, and all of the structures of the borders of the abdominal wound except the skin; close the skin with silkworm-gut sutures, leaving in sight the apex of the cone from

them that each will include, at the extremes of an interval of three fourths
of an inch, half an inch of corresponding portions (*d*) of the stomach;
tie the sutures firmly (Fig. 1096), drawing together the included tissue
and thus forming two longitudinal folds; push into the stomach the in-
folded tissues, causing contiguous serous membrane to come in contact with
the tube; unite together as before two additional folds, thereby covering in
the preceding ones, and thus lengthening the canal in which the tube yet
remains (Fig. 1097); leave the sutures long for a time (Fig. 1098), thus
securing better command of the stomach; stitch the stomach to the
denuded borders of the peritonæum and sheath of the rectus simultane-
ously; close carefully the external wound with sutures.

Gibson, through a small intermuscular dissection over the cæcum, ex-
posed and practiced the Kader plan on that organ, thereby affording oppor-
tunity for medicated flushing in the treatment of obstinate colitis.

Weir adjusted the appendix (appendicostomy) to a similar opening for
a like intention. These means have been effectively employed for flushing
purposes.

The Remarks.—If the stomach can not be brought into the wound on
account of its small size or the presence of adhesions, deep occlusion sutures
are employed to draw it up and unite it to the opening, thus closing the
peritoneal cavity. If this measure fails, the stomach is opened in the
abdominal cavity. *Meyer* has met with an instance of this kind. Perpen-
dicular folds of the coats of the stomach should be formed in permanent
fistula; the transverse in the temporary. On removal of the tube the open-
ing is guarded by the valvelike infolding of the stomach wall.

The Results.—Thus far the outcome from this method is very good. In
ten cases operated on by Mikulicz all made satisfactory recovery.

Andrew's Method.—This method can be practiced by making a vertical
incision through the anterior wall of the stomach two inches in length,
through which a portion of the wall immediately below is drawn upward
and exposed, with the mucous membrane uppermost. The tube is then
placed on this membrane in the line of the incision into the stomach, and
the membrane only is divided at either side of and parallel with the tube
at such a distance that the strip of membrane thus formed will surround
the tube when its borders are united. The distal borders of this incision
are then brought over the already covered tube and united by sutures. The
gastric wound is closed around the tube, the stomach connected to the
abdominal wall, and the external opening closed around the tube in the
usual manner. Practical experience in the use of this method is required
to establish its comparative value and freedom from seemingly difficult if
not dangerous operative technique.

Marwedel's Method.—The stomach is exposed through the oblique in-
cision, united to the abdominal wound, and the serous and muscular coats
are divided obliquely for about two inches down to the mucous membrane,
which is then perforated at the cardiac end, the end of the tube inserted
into the stomach (Fig. 1099), and the remainder covered over by union
of the borders of the serous and muscular coats with a buried suture, and
the external wound is closed (Fig. 1100).

The Results.—The results thus far (five in number) are flattering—four recovered, and one died on the following day from the effects of inanition.

The choice of operation will depend very much, indeed, on the condition of the patient, the size and mobility of the stomach, and whether or not a permanent canal is required. The condition of the patient permitting, and a permanent opening being required, the Ssabanejew-Franck method as modified by Kocher is all that can be desired. If it be found that the
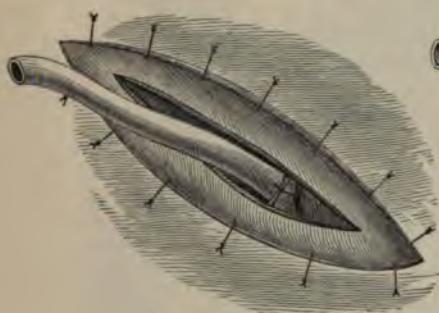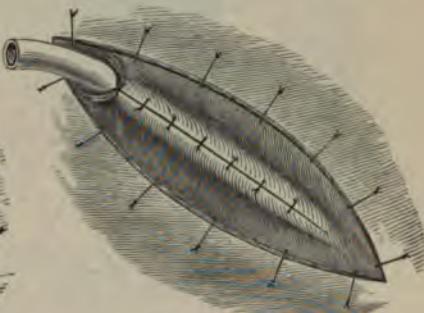
<div align="center">FIG. 1099.   FIG. 1100.</div>

FIG. 1099.—Marwedel's method of gastrostomy. Incision made, tube inserted and stitched in place.

FIG. 1100.—Marwedel's method of gastrostomy. Tube covered by suturing together muscular and serous coats.

stomach is small or adherent, an exchange for the plan of Kader or Witzel may be made with satisfactory results. If a temporary opening be in view and the conditions of the patient are favorable, the method of Senn, of Marwedel, and even the older plan first described, can be practiced. If the condition of the patient is precarious, as is too often the case, the older method only may be advisable. It seems proper to say in this connection that one should select that method of practice with which he is most familiar, provided, of course, other things are equal. The employment of cocain anæsthesia is commended in those instances of exhaustion requiring haste and simple technique and those unsuited for general anæsthesia.

Gastro-enterostomy.—Gastro-enterostomy signifies the establishment of a permanent fistula between the stomach and some part of the small intestine to secure proper emptying and rest of the stomach. Therefore, the nomenclature of the operation can be extended to conform to the special part of the small intestine concerned in the procedure, as gastro-duodenostomy, gastro-jejunostomy, gastro-ileostomy, etc.

The Anatomical Points.—The relations of the greater and lesser abdominal sacs to the stomach, transverse colon and its mesocolon, the jejunum, and the duodenum, and the arrangement of the great omentum, should be considered carefully before beginning the operation (Fig. 1078). Only a brief mention of the most striking points can be given here for obvious reasons. The anterior wall of the stomach is in the greater, the posterior in the lesser sac. The inferior wall of the transverse colon is in the for-

61**

mer, the superior wall in the latter sac, and the transverse mesocolon sepa-
rates the two horizontally.   The mesentery extends downward from be-
neath the transverse mesocolon near its attachment—ligament of Trietz
(Fig. 1102)—at which point the beginning of the jejunum is located.   The
great omentum hangs from the greater curvature of the stomach and the
lower surface of the transverse colon, covering over the latter.   The
omentum may be hollow, the cavity communicating with the lesser sac
above the colon (Fig. 1078); more often its layers are adherent to each
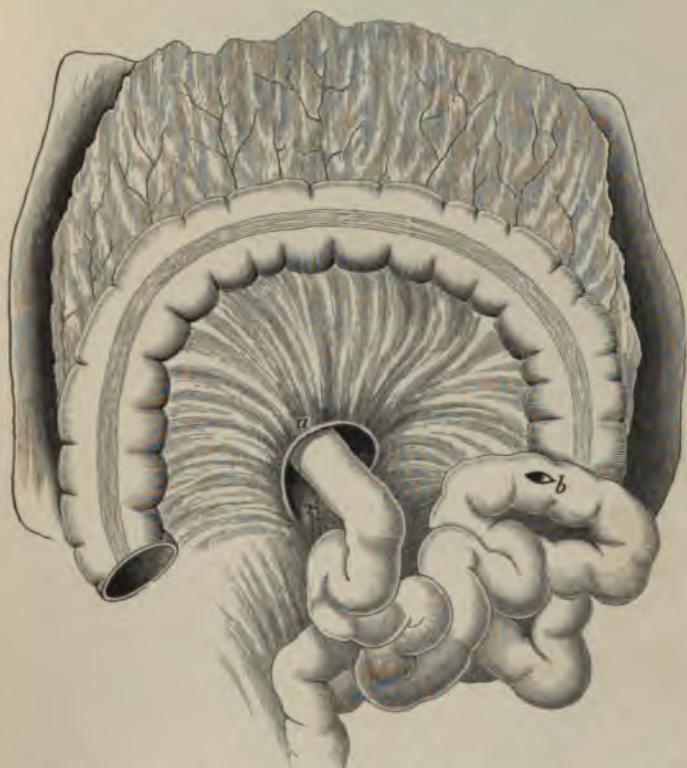
Fig. 1102.—The operation of gastro-enterostomy.   *a.* Ligament of Trietz.   *b.* Opening
into jejunum.

other.   It varies in density: is sometimes thick, again extremely thin, even
diaphanous.   It may be smooth, roughened, often crumpled, and either free
or adherent to the intestines beneath.   It can be carried upward over the
colon and stomach or to one side, more easily to the left.   These simple facts
exercise an important bearing on the manipulation of the structures.   The
jejunum must not be confounded with the ileum.   The former is of a
brighter color, denser and smoother in structure, and of a greater capacity
than the latter; its walls also are thicker, and the root of its mesentery is
higher.   The jejunum is readily seized by passing the thumb and finger
along the under border of the transverse mesocolon to its root and grasp-

ing the first intestinal loop that is felt immediately below. If this intestine be pulled toward the wound in a limited degree, the movement is arrested by the intestine's connection with the immovable part of the duodenum. If pulled so as to make traction on the opposite extremity of the loop, arrest does not happen because of its continuity with the remainder of the movable small intestine. Although not anatomical, it is needful to note that the flow of digestive matter in the stomach is principally along the greater curvature, from the cardiac toward the pyloric extremity, and that the reverse is the course at the lesser curvature of the stomach. In the
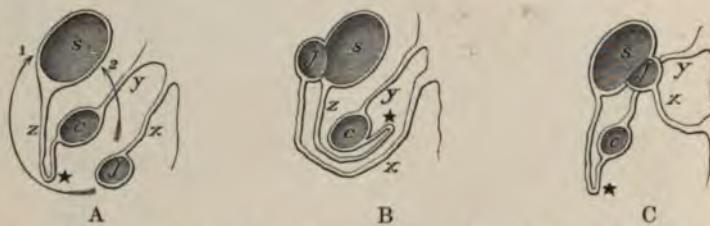
FIG. 1103.—The operation of gastro-enterostomy. Scheme of relations in the attachments of the jejunum to the stomach.

s. Stomach. c. Transverse colon. j. Jejunum.
z. Gastro-colic omentum. *. Great omentum. y. Transverse mesocolon.
x. Mesentery.
A. 1. Course of jejunum to anterior surface of stomach.
   2. Course of jejunum to posterior surface of stomach.
B. Relations of parts in anterior gastro-enterostomy.
C. Relations of parts in posterior gastro-enterostomy.

cardiac two thirds of the organ the food is propelled in a uniform gentle manner in the directions above stated. At the pyloric third it is more pultaceous, and is expelled into the small intestine in an intermittent and somewhat forcible manner. In the intestine the course is downward along the canal. These facts are of importance in the technique of union of the intestine with the stomach in the absence of special provision to neutralize the influence of the contact of opposing currents at the seat of anastomosis. *Two varieties of procedure have been devised, known respectively as anterior and posterior gastro-enterostomy.* In the former, the small intestine is passed in front of the transverse colon and joined to the anterior surface

FIG. 1104.—Gastro-enterostomy anterior (diagrammatic).

of the stomach (Fig. 1103, B); in the latter the intestine is carried either through the transverse mesocolon or gastro-colic omentum and united to the posterior surface of the stomach (Fig. 1103, C). An objection to the former method (Fig. 1104), though easier of attainment, is the stronger tendency to regurgitation of the intestinal contents into the stomach; to the latter, the greater difficulty of joining the parts, and the greater danger of peritoneal

infection and of kinking of the intestine on account of the influence of the tissues through which it passes. The regurgitation into the stomach of intestinal contents happens from the proximal end of the intes-
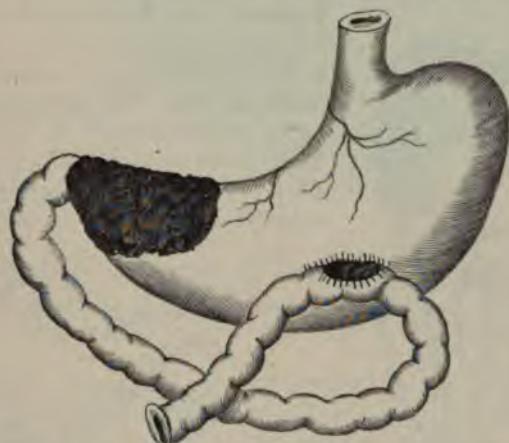
Fig. 1105.—The operation of anterior gastro-enterostomy. Union of a half-twisted loop with stomach.

tine in one of two ways: 1, The opposing currents fill the intestine directly, which finally expels its contents into the stomach; 2, the fluids may gain the intestine by way of the pylorus, and whether added to or not by direct
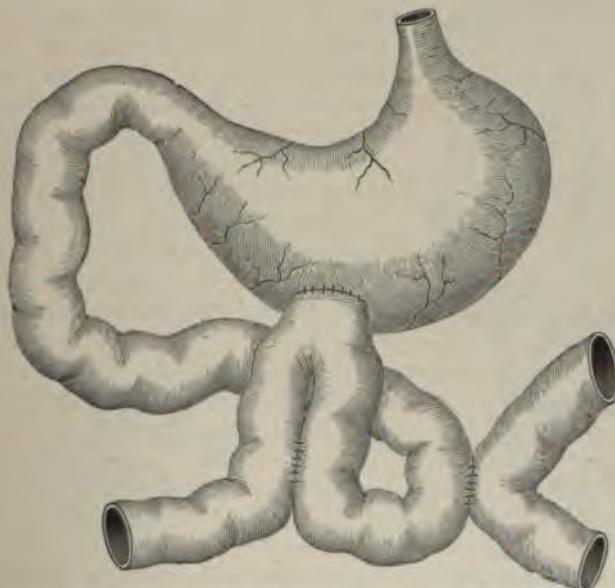
Fig. 1106.—The operation of anterior gastro-enterostomy. Entero-anastomosis, Braun's method.

reception from the stomach, they are expelled into the stomach the same as before.

The prevention of the entrance into the stomach of the intestinal contents and entrance of the products of the former to the intestine are promoted by the following plans of action: 1, By union of a half-twisted loop of intestine with the stomach (Fig. 1105), thus causing a similarity in the direction (left to right) of the flow of the contents of the united organs (Rockwitz). Unfortunately, however, the anticipated benefit was not fully realized,

Fig. 1107.—The operation of anterior gastro-enterostomy. Entero-anastomosis at point of intestinal crossing, Lowenstein's method.

Fig. 1108.—The operation of anterior gastro-enterostomy. Entero-anastomosis, Jaboulay's method.

because the curve fashioned by the operation disappeared with return to the abdomen of the parts, and was soon followed by the development of a spur at the seat of union which caused a short-circuiting of the fluids through the stomach and proximal limb of the bowel; also, great distention of the duodenum happened not infrequently, and, furthermore, the constriction incident to the pressure of the loop overlying the colon (Fig. 1103, B) was regarded with disfavor. 2, By multiple anastomosis (entero-anastomosis) (Braun); 3, by valve formation and compression ad-
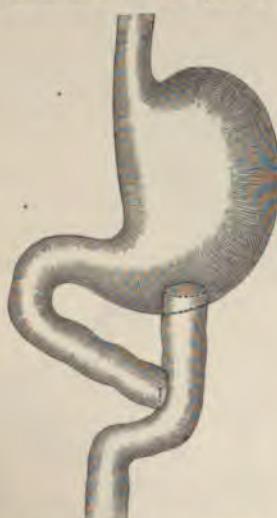
Fig. 1109.—The operation of gastro-enterostomy. Entero-anastomosis, Wölfler's later method.
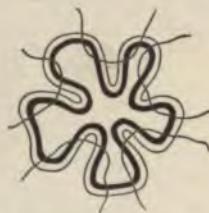
Fig. 1110.—The operation of anterior gastro-enterostomy. Narrowing of proximal of bowel by means of transverse sutures, Von Hacker's method.

justment of the parts (Kocher); 4, by posterior gastro-enterostomy (Von Hacker). Fowler's plan (page 918).

Entero-anastomosis (Braun).—Entero-anastomosis is practiced in gastro-enterostomy to cause the discharge of the contents of the proximal part
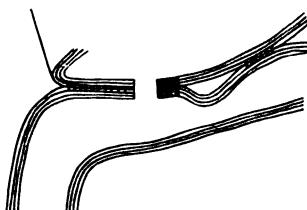
FIG. 1111.—The operation of anterior gastro-enterostomy. Narrowing of the pylorus and duodenum, Doyen's method. Longitudinal section.
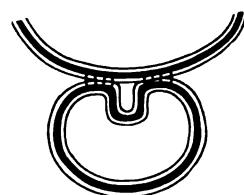
FIG. 1112.—The operation of anterior gastro-enterostomy. Narrowing of the pylorus and duodenum, Doyen's method. Transverse section.

of the intestine into the general intestinal current so far below the point of junction of the stomach with the intestine as to divert its course from the latter situation (Fig. 1106). When connected in the manner indicated in the cut, the contents of the duodenum are short-circuited through two channels—viz., into the jejunum below the point of union with the stomach, and also into the contiguous loop of intestine at the left side of the same point. At the same time the union of the loops of viscera harmonizes the direction of the flow. Lowenstein (Fig. 1107) and Jaboulay (Fig. 1108) made a second anastomosis (entero-anastomosis) lower down, followed by Wölfler with his later plan (Fig. 1109). The functional advantage gained by the use of either of these methods is too often an inadequate recompense for the depressing effect on the patient of the longer time employed and the greater danger incurred from infection by the adoption. Not a few attempts directed to the gut have been proposed to prevent the reflux of the stomach contents into

FIG. 1113.—The operation of anterior gastro-enterostomy. Valve between stomach and intestine, Chaput's method.

the proximal part of the bowel. The methods of Von Hacker (Fig. 1110), Doyen (Figs. 1111, 1112), Chaput (Fig. 1113), and Kocher are each commendable for their ingenuity, but Kocher's only contributes sufficiently to commend its utilization when posterior gastro-enterostomy can be practiced.

Kocher's Method.—After thorough cleansing of the stomach by means of a boric-acid or other suitable solution, and aseptic treatment of the operation field, make an incision in the median line four to six inches in length down to the peritonæum; arrest hæmorrhage; divide the peritonæum the full length of the incision; introduce through the entire thickness of each border of the wound one or more strong traction sutures; push the omentum upward or to the left; pass the fingers beneath the transverse colon along the under surface of the transverse mesocolon, and seize the nearest loop of intestine as already described. Draw the loop into the

wound and determine its identity after the method adopted for recognition
of the jejunum (page 905) ; place the end of the loop, which is formed at a
point about sixteen inches from the beginning of the jejunum, against the
anterior surface of the stomach near the middle, so that " the proximal
portion of the loop ascends and the distal portion descends " (Fig. 1114) ;
suture the proximal part of the loop to the stomach, allowing the distal
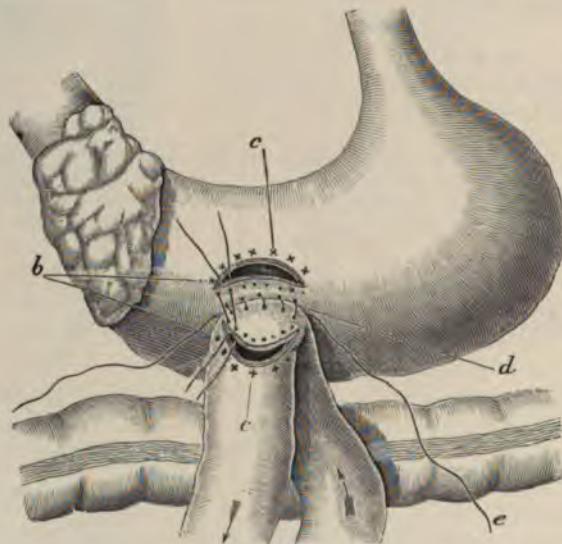
FIG. 1114.—The operation of gastro-enterostomy, Kocher's method. *a.* Valve formed
from jejunum. *b.* Location of sutures of posterior segment. *c.* Location of su-
tures of anterior segment. *d.* Posterior continuous suture. *e.* End of posterior
suture left for use as anterior suture.

part to lie freely upon the proximal; form a valve in the distal part of the
intestine near the stomach by making a curved incision through it for
about half of its circumference, the flap thus made having a transverse
base with convexity upward; unite the outer surface of the base of the
valve with the lower edge of a corresponding wound in the stomach, the
convex border remaining free.   Join the upper border of the opening in
the stomach with the concave border of the opening in the intestine result-
ing from the valve formation.   Interrupted or continuous silk sutures are
employed for these purposes; usually the former and sometimes both
together.   The mechanism of valve formation and compression adjustment
is explained by Kocher as follows : " The valve forces the escape of the stom-
ach contents into the distal part of the intestine and prevents the entrance
into the stomach of the contents of the proximal segment of intestine by
directing them along into the distal portion.   The compression of the distal
part while in active use closes the underlying proximal end at the seat of
union, which is in turn readily opened by the escaping contents of the prox-
imal part when the distal is not in action."   During the entire procedure
immunity from infection incident to the making of the openings into the

stomach and intestine, and from other steps of the procedure, is guarded against by gauze packing properly arranged around the abdominal opening, and by the exclusion of visceral contents from the sites of the incisions by digital manipulation and pressure. After thorough cleansing of the parts with the warm saline solution they are cautiously inspected for the presence of faulty sewing before being returned to the peritoneal cavity. The abdominal wound is then closed and dressed in the usual manner, and the patient is returned to bed.

Braun recommends a more precise method of union by joining with each other the borders of the respective tissues of the viscera as soon as they are divided. First unite the intestinal loop with the stomach by a long posterior continuous suture carried through the serous surfaces only, both ends being left long. Make an incision at the proper place through the serous and muscular tunics only of the organs, and unite the several borders posteriorly with each other by an independent suture; press aside the contents of the stomach and intestine with the fingers, holding the parts securely in position; open into the intestine and stomach by division of their mucous membranes, and unite the borders of the mucous membranes with each other by a continuous anterior mucous-membrane suture; introduce a second anterior suture, which passes through the entire thickness of
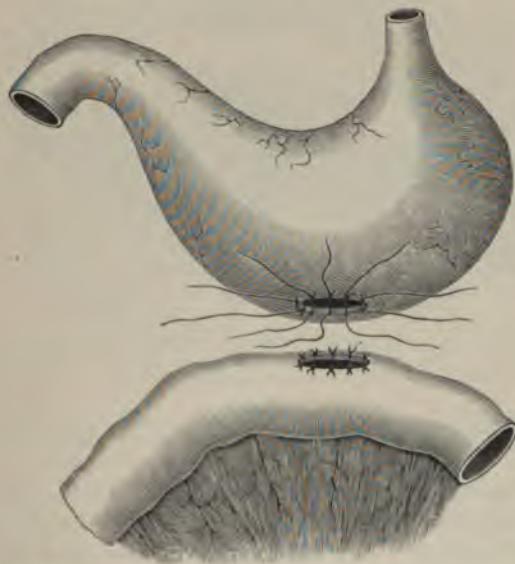
Fig. 1115.—The operation of gastro-enterostomy, Sonnenberg's method. Sutures in place.

the walls of the respective viscera; and, lastly, introduce a final anterior musculo-serous suture, which is formed by utilization of the ends of the long posterior serous suture before described.

Sonnenberg's Method.—Pass through and fasten to the borders of the incision into the stomach at short intervals numerous long silk sutures;

make an incision into the long axis of the small intestine, and sew its
borders with an overhand continuous suture of catgut (Fig. 1115) ; make
another opening into the small intestine, an inch or so below the former ;
introduce the ends of the gastric sutures into the primary intestinal open-
ing, carry them out through the secondary intestinal one, and by gentle
traction on them bring the borders of the gastric and intestinal openings
in contact with each other (Fig. 1116) ; they are united together in this
position by silk sutures applied in the usual manner. It should be noted
that the method recalls Maunsell's (Fig. 929) in one essential particular—

Fig. 1116.—The operation of gastro-enterostomy, Sonnenberg's method.
Sutures ready for approximation.

the long sutures. The ingenuity of these methods surpasses considerably
their present practical utility when compared with more modern plans of
procedure.

Posterior Gastro-enterostomy (Von Hacker).—After the usual gastric
preparation and other preparatory steps, make an incision in the median
line from a point two inches below the xiphoid cartilage to a point below
the umbilicus (Fig. 1101), increasing thereafter the length in either direc-
tion as may be required ; raise and push upward over the stomach the
omentum and the transverse colon (Figs. 1117 and 1103 C), and hold them
in place with sterilized gauze compresses ; recognize and isolate the begin-
ning of the jejunum ; cause an assistant to so grasp the stomach with both
hands that the fingers will be applied to the posterior and the thumbs to
the anterior surface of the organ ; pronate the forearms, thus pressing the
posterior wall downward and upward against the transverse mesocolon ;
slit the mesocolon parallel with its vessels at the point of proposed entrance
to the stomach with forceps ; cause the stomach to protrude through the

slit by pressure of the thumbs, and promptly stitch the separated borders of the slit to the posterior wall of the stomach (Fig. 1118); push aside the contents of the first loop of the jejunum for the distance of six or eight inches, with the thumbs and fingers, and apply proper clamps to prevent their return; apply, with or without looping (Figs. 1117, 1118), the empty segment of gut to the posterior wall of the stomach, and unite these with each other at the lower border by means of sutures passed through the sero-muscular coats only; open the stomach obliquely downward from left to right for two inches; open the intestine in the long axis of the free border a similar distance, and unite the borders of the respective openings with each other in the usual manner by sewing; remove the proximal intestinal clamp, and narrow this part of the intestine near the anastomosis by infolding the walls longitudinally in several places, and confining them in this position by sutures passed through the sero-muscular coats of the projecting borders, thereby forming a rosette outline of the lumen of the gut
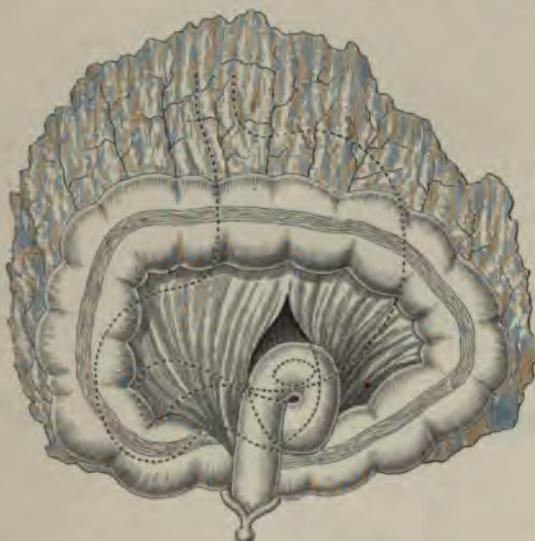
Fig. 1117.—The operation of posterior gastro-enterostomy. Jejunum looped to secure uniformity of peristalsis, Von Hacker's method.

at this situation (Fig. 1110). Entero-anastomosis may be practiced instead (pages 907 and 908). The parts are then cleaned thoroughly, the protective packing is removed, the viscera are returned into place, and the abdominal wound is closed by tier suturing.

The Remarks.—Von Hacker claimed that the facility of procedure and freedom from the danger of peritoneal infection when the parts are thus manipulated are equal to those in the method of union at the anterior surface of the stomach, and that the liability to intestinal kinking and regurgitation of intestinal contents into the stomach is reduced to a minimum for all operations, which subsequent experience has confirmed. The contentions of many others that the manipulations of the stomach in this method

being harsh at the best, and the opportunity for proper union of the viscera and prevention of peritoneal infection being greatly hindered, thereby neutralizing the additional advantages gained in favor of this method of practice, have not proved true. Certainly, the uniformity in the direction of the flow of the contents of the viscera, and their more natural position, together with the influence of the force of gravity on the contents of the stomach, emphasize the wisdom of this method. Practically the influence of gravity seems sufficient to meet the requirements, as direct anastomosis (Fig. 1118) is now quite commonly employed with satisfactory results. Transverse division of the mesocolon should be avoided, because of the great liability of injury to the vascular supply of the colon and the danger of subsequent gangrene. Cautious and effective suturing of the stomach to the separated borders of the opening in the mesocolon prevents undue traction
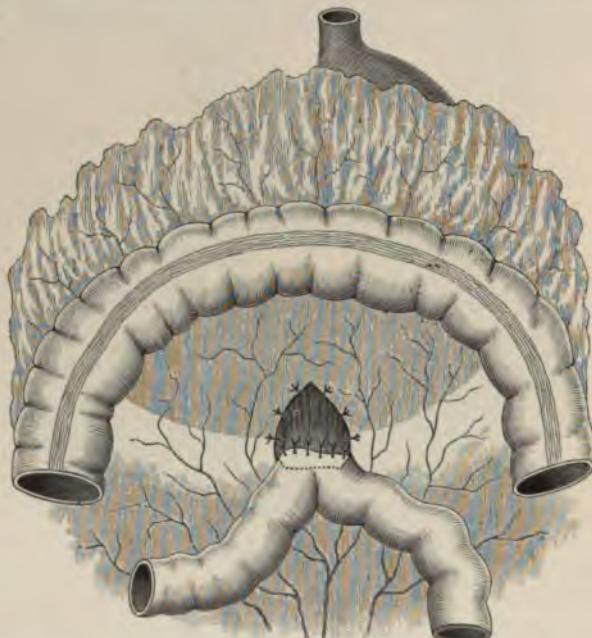
Fig. 1118.—The operation of posterior gastro-enterostomy. Transverse colon and omentum turned up, transverse mesocolon slit sutured to stomach, and intestine directly united to stomach, Von Hacker's method.

on the intestine and the occurrence of a slit through which the intestine may escape with dangerous results. The employment of a medium-sized Murphy button (page 917) to unite the intestine with the stomach, and a small one for entero-anastomosis, has shortened the time of the operation so much that its scope has been considerably extended and the results much improved. The making of an opening through the gastro-colic omentum is not a matter of trifling significance.

Roux's Method.—Roux, after turning up over the stomach the great omentum and the transverse colon, made an opening through the posterior

border of the transverse mesocolon a little to the left of the median line of the vertebral column, thus exposing the stomach near the pyloric end. The jejunum was then divided several inches from the plica duodeno-jejunalis (Fig. 1119), the distal end of the bowel implanted by sewing into the posterior surface of the stomach (*c*), and the proximal end (*a*) united in the same manner with the distal at a point below the connection of the latter

FIG. 1119.—The operation of posterior gastro-enterostomy, Roux's method. *a*. Proximal end of jejunum. *b*. Union of proximal and distal ends of jejunum. *c*. Distal end of jejunum joined to pyloric portion of stomach.

with the stomach (*b*) (Fig. 1119). The employment of the Murphy button in this instance would no doubt greatly facilitate the operation.

Monprofit practices posterior gastro-enterostomy with the Murphy button in a simple and effective manner. He divides the jejunum transversely four or five inches from its origin and inserts half of the button into the proximal end. The other half he introduces into the open end of the distal part of the divided intestine, carrying it down five inches, where the shank is carried through a small incision made in the lateral wall of the intestine, and then carefully coupled with its fellow in the end of the proximal part of the gut. The open end of the distal portion of the jejunum is then buttoned to the posterior wall of the stomach. This method is quite promptly done and obviates the " vicious circle."

The General Precautions.—As complete isolation as is possible of the operation field by aseptic packing and use of rubber dam should be practiced in gastro-enterostomy to prevent peritoneal infection. The occurrence of this misfortune calls for patient and thorough cleansing, and perhaps for the establishment of effective drainage. The line of each form of union should be carefully inspected, and points of doubtful coaptation should be fortified by additional stitches before the return of the viscera, as post-operative leakage will be promptly fatal. The exclusion of the contents of the organs from the seat of proposed union must be rigorously practiced by every practical method (page 805), for obvious reasons. The development of a post-operative peritonitis indicating infection calls for prompt exposure of the parts, to repair defects and remove deleterious agents. The tendency to kinking of the gut by operative confinement or constriction from superimposed weight or pressure should be anticipated and remedied in the first instance by supporting sutures applied at either side of the anastomosis (Kappeler) before the abdomen is closed. A sharp bend in the jejunum beyond the point of union with the stomach, its constriction at the seat of the slit in the mesocolon, and closure of the transverse colon by the pressure of the loop of intestine carried in front of it for attachment to the stomach, are practical illustrations of these dangers. The shorter the loop consistent with proper slack the better appears to be the result. Shorter loops can be utilized with posterior than with anterior gastric attachment. Short loops expose the duodenum less to ulceration incident to the acid gastric secretions than long ones (Mayo). Murphy regards a too long loop (12 to 18 inches of jejunum) as the not infrequent cause of the " vicious circle," and advises that the anastomosis be made posteriorly into the stomach three or four inches from the pylorus and into the jejunum " three to five inches from the ligament of Trietz." In this connection it is proper to note that the duodeno-jejunal angle is fixed by the muscle and ligament of Trietz. Gastric alimentation of small amount, and of a fluid and bland nature only, should be given for the first few hours, if circumstances will permit, rectal alimentation of a more substantial character being employed at the same time. That the opening of intercommunication should be sufficiently large to obviate complete closure is clearly apparent. An opening two inches in length in incision cases is regarded as ample to prevent this sequel. An impairment of the vascular supply of the viscera should be avoided by careful treatment of the mesentery to obviate the danger of gangrene of the intestines. Only the upper part of the jejunum should be utilized, remembering that the danger of death from inanition increases in proportion to the exclusion of the small intestine from the field of nutrition. The anastomosis should be made at a point as far as possible from the seat of the disease and as near the greater curvature as practicable. The anastomotic point of the jejunum usually selected is from twelve to fifteen inches from its duodenal junction. Measures should be taken in every instance, when possible, to prevent the pancreatic and biliary fluids, as well as those of the stomach itself, from returning to the stomach by regurgitation and short-circuiting, for reasons both obvious and well understood. The intermittent, expulsive character of the

movements of the pyloric end of the stomach during digestion (page 756) suggests the wisdom of making the anastomosis at this situation when practicable. Peptic ulcers follow anterior but not posterior gastric anastomosis. The employment of valvular-flap devices for the purpose is less reliable, more difficult and complicated than that of the Murphy button, the bone bobbin, and other similar agents.

Entero-anastomosis with the Murphy button can be quickly carried into effect—after opening the intestine for union with the stomach—by introducing through the opening, by means of ordinary forceps (Gallet) (Fig. 1120), or forceps devised for the purpose (Turnure), a segment of button into each limb of the intestine in such a manner that, when closed by opposing pressure, the stems of the segments penetrate the intervening tissues and complete the anastomosis when locked. The need for entero-anastomosis appears to be lessened by absence of slack of the intestinal loop.

The Results.—*Murphy* reports with the use of his button: Of 1,620 cases of Murphy button anastomoses for all causes, 20 per cent died. In 700 cases of gastro-enterostomies done with Murphy button, the mortality was 19 per cent. Of these, 166 were non-malignant, in which the mortality was 2.3 per cent. Entero-enterostomy was made with the Murphy button in 750 cases for all causes, with a mortality of 19 per cent. In the non-malignant cases of this sort the mortality was 14.4 per cent (recent written communication).

The Remarks.—The careful evacuation and disinfection of the stomach and intestines before operation is a wise precaution, and a time-saving measure during operation, as the tendency to and danger of infection is lessened by this means. Preparatory stimulation and strengthening of the patient is advisable when the already depressed state demands it and time will permit. The

Fig. 1120.—The operation of entero-anastomosis, Gallet's method, with ordinary forceps. *a.* Weir's modification of stem of Murphy's button.

continued regurgitation into the stomach of the intestinal contents is deleterious in an extreme degree, and should be combated by lavage, medication, and opposing posture. The median abdominal incision is commonly employed in this operation. If freer exposure of the parts is desired, this incision may be supplemented by a transverse one three or four inches in length made at right angles with the former. Union by Halsted's method of sewing is secure and promptly accomplished (page 789), and the importance of the submucous fibrous tissue in this connection should be kept in view (Figs. 914 and 915). The Murphy button affords the quickest means of union, but is open to the objection of

sometimes remaining indefinitely as a foreign body in the stomach or intestine. It does not appear, however, that the retention has been followed by troublesome sequels. A relative increase in the intestinal end of the button seems likely to favor its escape into the intestine, thus lessening the frequency of its entrance to and retention in the stomach. The use of the Murphy button may prevent entirely, and certainly will for some time, the formation of a spur, but in some cases marked contraction of the anastomotic opening takes place. *Weir* bevels the end of the stem of the male part of the button (Fig. 1120, *a*) to facilitate perforation of the intestinal wall in entero-anastomosis by Gallet's method. Also Weir * practices the attachment of a string between the beveled part of the button above and the one below for entero-anastomosis (Fig. 1120) with the idea of preventing the escape of the former into the stomach. The miscarriage of this novel idea might readily yoke together the buttons in several uncanny situations. *Carle* draws the borders of the intestinal opening around the stems of the button by one or two Lembert sutures, instead of by the purse-string suture commonly employed (Fig. 944).

Fowler prevents the "vicious circle" by occluding the ascending arm of the bowel with silver wire passed three times around it between the points of gastric anastomosis and entero-anastomosis. Eight consecutive successful cases are recorded (personally reported to author).

Moynihan's Method. †—This, a recent plan of Moynihan, is comparatively simple, promptly effective, and can be employed generally in abdominal anastomoses.

The Operation.—Open the abdomen through a vertical incision of suitable length made about three quarters of an inch to the right of the median
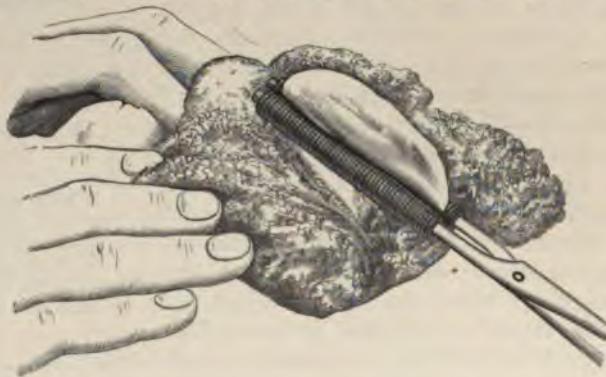
FIG. 1121.—Gastro-enterostomy. Moynihan's method. Suture of stomach.

line, splitting the fibers of the rectus; draw apart the borders of the wound, expose and raise out of the abdomen and turn upward over the epigastrium the transverse colon and the great omentum; expose the under surface of the transverse colon and observe the vascular arch of the middle colic

* Jour. Amer. Med. Assn., September 17, 1904.
† The Practitioner, February, 1904.

artery; make through the mesocolon (avoiding vessels) a small incision and pass the finger through it into the lesser peritoneal sac (Fig. 1078), then enlarge the opening by stretching, until the fingers can be forced through; pass the hand along the anterior surface of the stomach and push the stom-
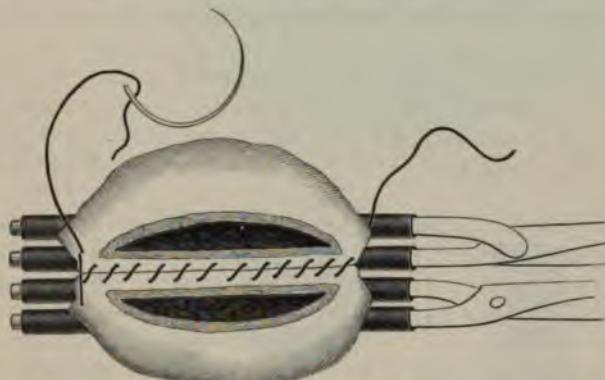
FIG. 1122.—Gastro-enterostomy. Moynihan's method. Jejunum seized, clamps brought side to side, the first row of sutures, viscera incised.

ach up into the wound, so that its posterior surface will present, pulling it well out; seize a fold of the stomach about three inches in length extending from the greater curvature obliquely upward toward the cardia with the clamp (Fig. 1121), the blades being covered with rubber tubing; sweep
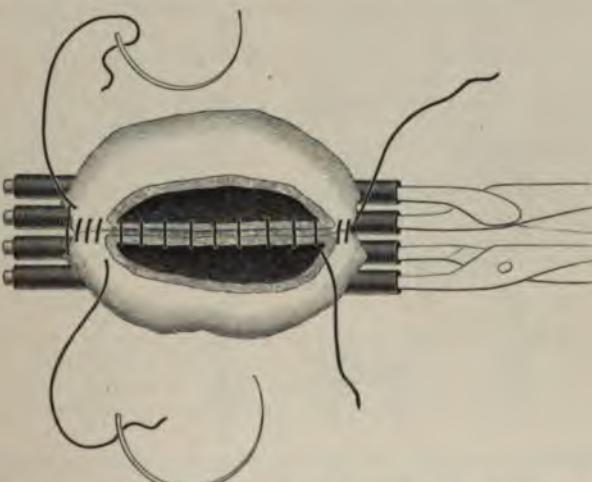
FIG. 1123.—Gastro-enterostomy. Moynihan's method. The inner suture introduced.

the finger along the under surface of the transverse mesocolon to the left of the spine, thus finding the beginning of the jejunum; bring to the surface a portion of the jejunum and properly seize it about seven or eight inches from the beginning with a second pair of clamps; place the clamps

side by side on the abdominal wall, returning to the cavity the underlying exposed portions of viscera; cover with sterile gauze wrung out in hot saline solution all except the portions of viscera exposed for operation; beginning at the left, unite together with a continuous suture (Fig. 1122), including the serous and muscular coats, the stomach and jejunum for not less than two nor more than three inches; make at either side of the line of
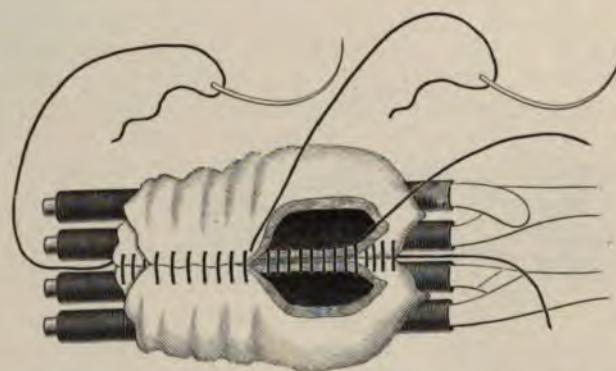
FIG. 1124.—Gastro-enterostomy, Moynihan's method, inner suture complete, the deep outer row commenced.

sewing an incision into the viscera down to the mucous membrane (Fig. 1122), noting the retraction of the serous and the pouting of the mucous coats along the incisions; loosen the mucous coats from the superimposed for a short distance and excise an eliptical-shaped piece from the mucous
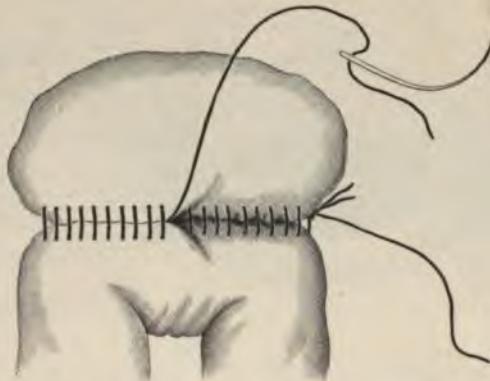
FIG. 1125.—Gastro-enterostomy, Moynihan's method. The completed deep outer sutures being covered in by the superficial outer row.

coat of each organ two inches in length and a little more than half an inch in width at the center, seizing the mucous borders to prevent their retraction; arrest all bleeding by ligature or by tightening the clamps; begin at the same end as with the preceding suture, and introduce an inner suture

(Fig. 1123) so as to include all of the coats of the viscera, placing the stitches sufficiently close together and drawing them sufficiently taut to arrest all bleeeding; continue the sewing with this suture, carrying it through the free borders of the respective organs, not quite to the point of beginning (Fig. 1124); loosen the clamps enough to permit of bleeding if liable to occur; stitch the bleeding points and complete the line of sewing to the point of beginning; tie together the ends and cut them off; resume the outer suture, covering in the inner one, and continue it round to the starting point, where its extremities are tied and cut short (Fig. 1125). Thus, two rows of sutures are introduced, the inner including all the layers of the viscera, the outer only the serous and subserous coats.

The Remarks.—Moynihan uses fine thread and a half circle needle in the sewing. Intestinal lateral anastomosis can be carried into effect in a similar manner. *Moynihan* commends his clamps for end-to-end union of intestines. For lateral anastomosis this device is excellent, but for end-to-end union there seems to be a better means.

McGraw's Method.—The simplicity and general availability of this method commend it to favorable consideration. The outcome of the prac-
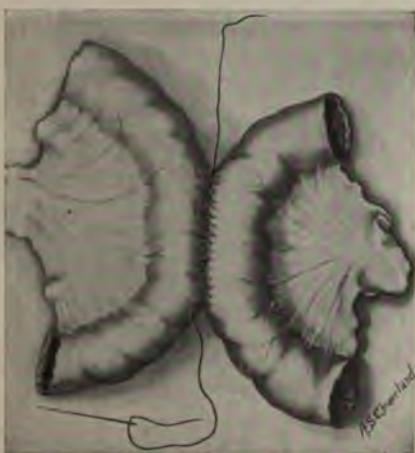
FIG. 1126.   FIG. 1127.

FIG. 1126.—McGraw's method of gastro-intestinal and entero-intestinal anastomosis. Uniting the viscera with running suture of silk.

FIG. 1127.—McGraw's method of gastro-intestinal and entero-intestinal anastomosis. Introducing the elastic ligature into place.

tice also at present further emphasizes the expediency of the method in suitable cases. However, when a prompt opening of the viscera is required, and when for any reason the stomach can not be suitably raised for the purpose, this plan can not be wisely considered.

The Operation.—Open the abdomen and expose the posterior surface of the stomach in the usual way; identify the jejunum (page 905) and select a point for anastomosis about sixteen inches from the duodenum;

bring in contact by the fingers of an assistant the stomach and intestine in a parallel line with the proposed opening; unite the viscera with a running suture of silk for three or four inches, not entering the cavity of either organ (Fig. 1126); arm a worsted needle with an elastic ligature not less than six inches in length and of a greater diameter than the needle; pass the needle at a point opposite the beginning of the running suture into the gut in its long axis, causing it to emerge at the opposite end of the suture, thus including three or four inches of tissue (Fig. 1127); repeat the procedure in a reverse manner through the wall of the stomach or intestine, bringing the ends of the suture close together; place a strong silk ligature at the point of proposed tying and form the first fold of the elastic knot, drawing the ligature as firmly as possible (Fig. 1128); retain in place this fold, and securely fix it there by tying around it the underlying silk ligature; complete the elastic knot, securing the second fold with the silk ligature in the same manner as the first; cut off the redundant ends of the ligatures (Fig. 1129), and complete the running suture, thereby burying
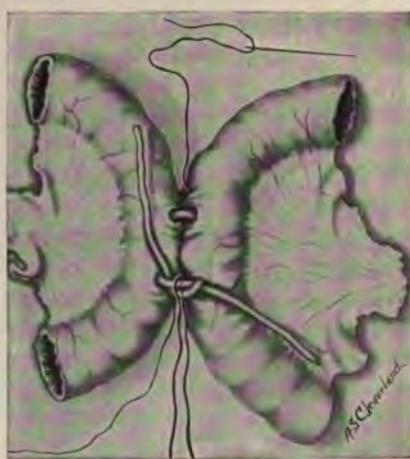
FIG. 1128.   FIG. 1129.

FIG. 1128.—McGraw's method of gastro-intestinal and entero-intestinal anastomosis. Tying the elastic ligature and holding it in place with the silk ligature.

FIG. 1129.—McGraw's method of gastro-intestinal and entero-intestinal anastomosis. The knot fastened, ends to be cut off, and knot buried by completing the running suture.

the elastic ligature (and knot) beneath the united walls of the viscera (Fig. 1130).

The Precautions.—The elastic ligature should be aseptic, new, smooth, not less than 2 millimeters in diameter, strong, and have been well tested by *vigorous* traction before introduction. Carefully isolate the parts with gauze before passing the elastic ligature to obviate infection. In burying the ligature after tying, be sure and adjust, carefully and smoothly, the united borders to secure complete and safe union; avoid acute bends of the intestines, because of danger of obstruction.

The Remarks.—Plain silk is better than catgut, as the latter is not permanent. The length of the time of sewing is governed by the size of the proposed opening. The continuous stitch should be secured at the beginning and also at other points by half hitches to prevent puckering. The first row of sutures should be near to the vessels at the great curvature of the stomach and to the mesenteric attachment of the small intestine. If

FIG. 1130.—McGraw's method of gastro-intestinal and entero-intestinal anastomosis. Completion of the running suture and burial of the elastic ligature in the united walls of the viscera.

traction be made on the elastic ligature during its passage, it is then made thin enough to pass readily, yet completely fills the openings in the intestine, and when relaxed makes impossible the escape of contents. The ligature should be smooth, elastic, and strong enough to resist full traction. Age causes rapid deterioration of the ligature. The folds in the included tissues caused by the tying disappear soon and the sutures are smoothed out. Entero-anastomosis may be practiced here as in the other instances because of the liability of the " vicious circle."

Maury,* with the idea of " punching out " a piece of selected size and shape, thus forming an opening of assured and fixed dimensions, passes the ligature from point to point through the apposed viscera so as to outline the desired opening, the borders of which are grasped by tying the ligature in the usual manner and securely environed by sewing the same as before. Further labor is needed in this direction to determine the wisdom of the modification.

Werelius † introduces a silk or twine ligature or a silver wire into the affected viscera as in the McGraw method (Fig. 1127). He covers in this agent by folding over and sewing together the viscera, leaving the ends of the ligature outside, which are then grasped and the ligature caused to

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cut an osteomatic opening by a sewing motion. The suture is then removed and all openings are closed with sutures.

The Precautions.—Avoid including the anterior suture in the grasp of the cutting ligature, also the occurrence of hæmorrhage and disturbance of the lines of sewing.

The Results.—Of 1,080 gastro-enterostomies made by methods other than the Murphy button, 252 (23.3 per cent) died; of these, 606 were done by *Von Hacker's* method, with 97 (16 per cent) deaths; 246 by *Wölfler's* method, with 91 (36.9 per cent) deaths; 104 by *Kocher's* method, with 44 (42.30 per cent) deaths; 84 with *McGraw's* ligature, with 2 (2.3 per cent) deaths, and the remaining 50 by various other methods, with 18 (36 per cent) deaths. *Carle* reports 60 cases of his own in which the Murphy button was employed without a death. His combined rate, however, was 7.4 per cent (Keen). *Czerny* operated in a series of 35 cases with Murphy's button with a mortality of 34.28 per cent, and later in a second series of 65 cases with a mortality of 22.28 per cent. *Murphy's* latest report of the use of his button: gastro-enterostomies, 575 cases; 417 reported results, with 317 recoveries, or 76.01 per cent; deaths, 24.03 per cent (written communication).

Decalcified bone plates, 61 cases with 14 deaths (Magill).

The average longevity after operation in malignant disease is about eight months; in non-malignant, sufficient time has not yet elapsed to establish a record.

Jejunostomy may be practiced when gastro-enterostomy is not possible by the method of Maydl (Fig. 1062) or Albert (Fig. 1531, *a*). In each the abdominal incision is made in the median line above the umbilicus; in the former the loop of jejunum is severed between suitable restraining appliances (Fig. 1006), and the proximal end is implanted into the convex surface of the distal part. In the latter plan entero-anastomosis (jejuno-jejunostomy) is performed, and the apex of the intestinal loop is carried out through the median incision, thence beneath the integument through a secondary opening as in gastrostomy (Fig. 1090).

Pylorectomy.—The term pylorectomy is applied to the operation for removal of the pylorus and as much of the stomach and duodenum as may be involved by the disease calling for the procedure. *Rodman* * and others strongly advocate the operation for cure of pyloric ulceration. Before beginning the operation, the attention of the surgeon should be directed carefully to the vascular supply of the pylorus and its relation to the nutrition of contiguous structures, as modified by the morbid effects of the disease (Fig. 1132). The probable complications incident to the procedure should be anticipated as far as possible, and the proper resources for their relief contemplated, in order that wise forethought may contribute to prompt and discreet action during the operation.

Preparatory treatment, characterized by frequent washing out of the stomach, regulation of the bowels, sterilized diet, and proper stimulation should, when possible, precede for some days the more active measures. In

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* Jour. Amer. Med. Assn., September 17, 1904.

FIG. 1131.—Instruments employed in operations on the stomach.

a. Scalpels. b. Bistouries. c. Forcipressure. d. Curved and straight scissors. e. Thumb forceps. f. Needle-holder. h. Retractor. i. Sponge-holder. j. Cleveland's ligature carrier. k. Aneurism needle. l. Blunt hook. m. Curved and straight needles. n. r. Silkworm and catgut. o. Traction loops. p. Straight, round, and curved needles threaded with black silk. q. Small and large gauze pads, with tapes, the large anchored to forcipressure. Broad retractors, tenacula, and rubber dam are needed.

63*

all instances the stomach should be completely emptied, and carefully washed by a mild antiseptic fluid, such as a boric or salicylic-acid solution, an hour or so before operation. Means calculated to prevent and overcome shock should be at hand (page 120, vol. i) for prompt utilization.

A careful counting of the sponges, pads, and of other agents employed in this and all abdominal procedures should be made at the outset, and their introduction into the cavity definitely noted by some responsible person in-
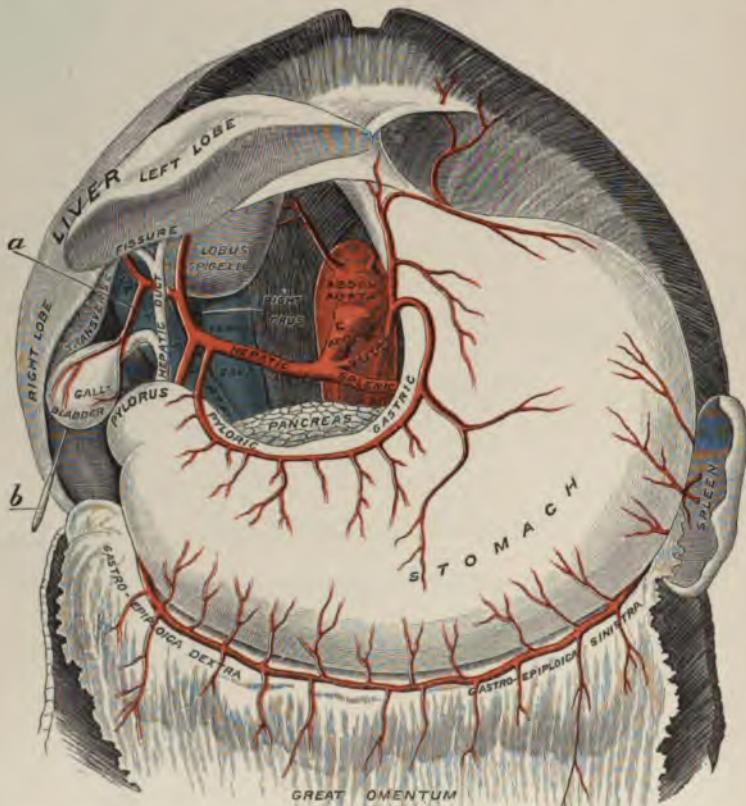
Fig. 1132.—The anterior surface of the stomach, showing its relations and vascular supply. *a.* Cystic branch. *b.* Probe passing through foramen of Winslow.

dicated for the purpose, in order that all may be accounted for before the abdominal wound is closed (page 93, vol. i).

The Anatomical Points.—The stomach lies obliquely downward and to the right, the cardiac orifice being at the left of the tenth dorsal vertebra and fixed in its relations. The pyloric orifice lies about an inch to the right of the eleventh or twelfth dorsal vertebra, which distance is increased an inch or two by moderate distention from internal causes. Also when moderately distended the lower curvature reaches to within an inch or two of the umbilicus. The wall of the stomach is thicker at the pyloric portion, at

which portion the mucous and muscular coats proportionately contribute the difference. The normal pyloric opening is a little less than half an inch in diameter. The blood supply is practically shown in Fig. 1132. The lymphatics of the stomach are numerous, and the nodes are located mainly at the right half of the great curvature (Fig. 1133) and at the middle and left thirds of the lesser. The vessels and lymphatics are so intimately associated with the stomach at the latter curvature as to require its removal along with them in cases of cancer (Mikulicz). The vessels and lymphatics of the greater are much less intimately connected, and therefore permitting of freer action at this part of the stomach. The lymph of the lymphatics of the lesser flows toward the cardiac end of the stomach (Fig. 1133), being finally discharged into the cœliac glands. The lymph of the left half (substantially) flows to the left into the splenic lymph glands and that of rather more than the right half to the right into the glands at the head of the pancreas. The nerves of the stomach are abundant and sensitive, comprising the terminal branches of the pneumogastric and the sympathetic branches of the solar plexus; hence the profound shock that so often attends severe blows and harsh or long handling of the stomach and the pylorus, especially the latter in instances of adhesions of this part of the organ. It is proper to add at this time that the modification in the size, position, and relations of the stomach due to disease are multifarious and perplexing. *An examination of the lymphatics of the stomach* shows that the lymph of about the left half of the greater curvature flows to the right, and that the corresponding portion above enters the vessels of the lesser curvature flowing to the left, giving therefore an ample part of the stomach not influenced directly in cancer of the pylorus by the lymph circulation; a fortunate arrangement when, as it appears, cancer of the stomach occurs in quite 70 per cent of the cases at the pyloric end, and in 60 per cent within three inches of it (Mayo). It logically follows that the *incision as indicated by Hartmann* (page 928) should be made to the left of the disease and of the recognized site of the glands at the greater curvature; also the removal of the lesser curvature and its associated lymphatic and other vessels, causing the line of incision to fall therefore from about the junction of the inner (cardiac) with the outer three fourths of the lesser curvature; thence downward to the greater curvature to the left of the disease and lymphatic glands at that situation.

The Operation of Pylorectomy (Kocher).—For the sake of a more lucid description, the operation can be divided into three stages of procedure: (1) exposure of the pylorus; (2) isolation of the pylorus; (3) resection of the diseased tissues. The primary incision is made in the median line.

The Exposure of the Pylorus.—Press upward the pylorus to the proposed site of the abdominal incision, if need be; make a vertical incision down to the peritonæum in the median line above the navel, of sufficient length to permit of digital examination of the diseased area; arrest hæmorrhage, open the peritonæum, introduce the thumb and index finger, and carefully estimate the extent of the disease and note the presence of glandular and other secondary involvements. If further procedure be advisable,
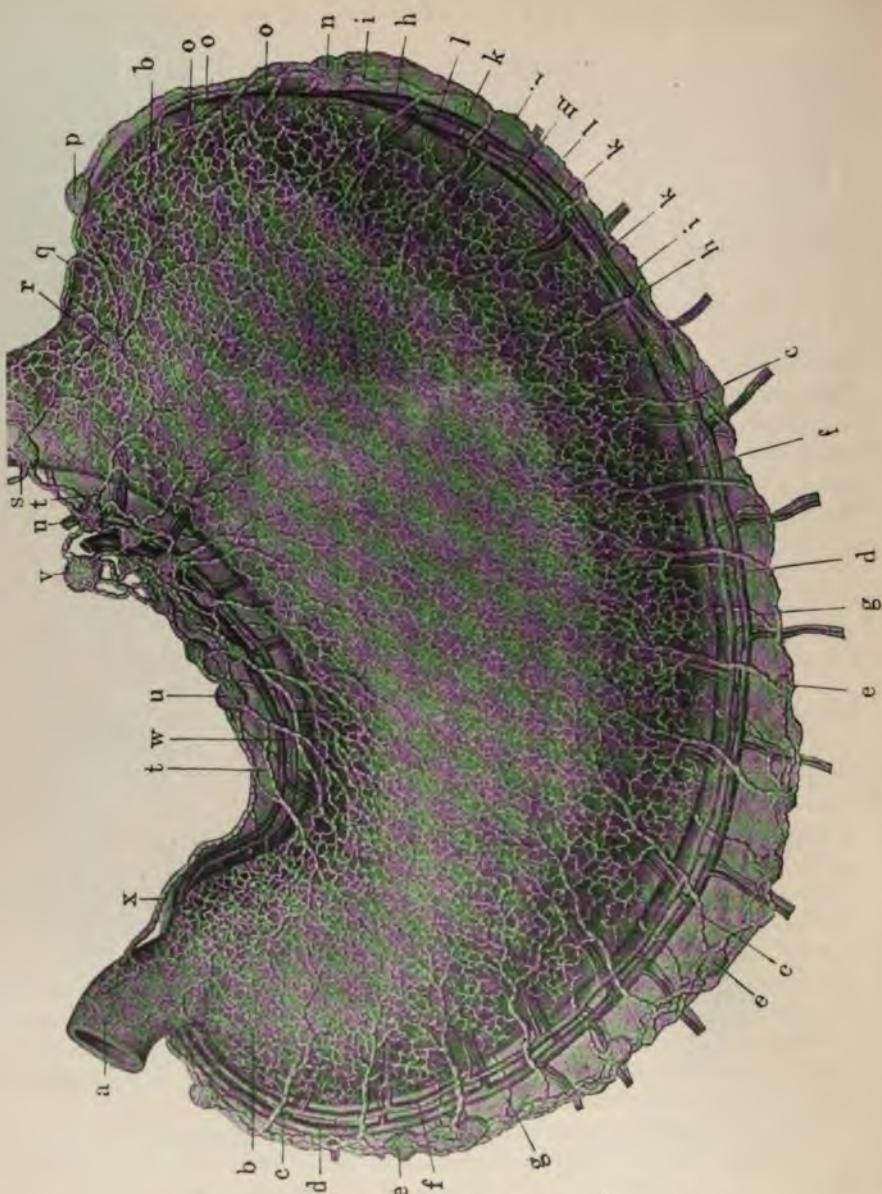
Fig. 1133.—The lymphatics of the human stomach.

a. Duodenum. *b, b.* Network of lymphatics. *c, c, c, g, g.* Trunks from anterior **and** posterior aspects of pyloric region. *d, f.* Vasa gastro-epiploica dextra. *e, e, e.* Chain of nodes on the right of great curvature receiving lymph from the right half next to this curvature. *h, h, k, k.* Lymphatics of posterior and anterior surfaces of left third of great curvature. *i, i, i.* Principal trunk, left half of great curvature; lymph enters large node (*n*) situated near tail of pancreas and hilus of spleen. *o, o, o.* Trunks from extreme left of stomach to gland (*n*). *l, l, m.* Vasa gastro-epiploica sinistra. *p.* Large node, of large lymph vessel joining vessel to nodes *r* and *p.* *s.* Lymph node of œsophageal lymphatics. *t, t.* Lymph vessels from lesser curvature. *u, u.* Lymph nodes along vessels of lesser curvature. *v.* Large lymph node (cœliac) receiving lymph from vessels at the right. *w.* Coronary vessels. *x.* Lymph vessel from duodenum and pylorus to glands at lesser curvature. (N. B.—Compare lymph nodes of this Fig. with the line of incision of Fig. 1144.)

introduce through the opening a broad, flat sponge or thick gauze pad to collect the blood, and extend the incision sufficiently for the purpose by means of scissors; arrest the bleeding points and make a second incision at right angles to the median, if necessary for the proper observation and manipulation of the parts.

The Remarks.—The incision in the median line in the making, for the arrest of hæmorrhage, and in subsequent union of the borders, is the best, as any needless increase of time is to be avoided.   However, the wound should be enlarged transversely to the right or left when expediency demands a more extended examination or manipulation than the median incision affords.   The presence, location, and the extent of adhesions, the existence and situation of enlarged glands and the involvement of the liver, gall bladder, pancreas, colon, or stomach, should be carefully determined. Adhesions between the stomach, the colon and liver, and enlarged glands near the pancreas, especially the head, at the lesser curvature of the stom-
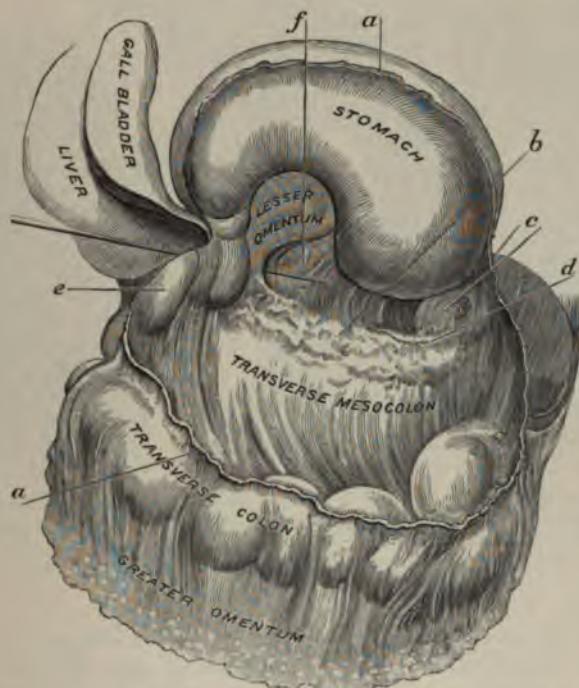
Fig. 1134.—The posterior surface of the stomach.   *a, a.* Gastro-colic omentum.   *b.* Pancreas beneath transverse mesocolon.   *c.* Spleen.   *d.* Splenic vein.   *e.* Descending duodenum.   *f.* Papillary tubercle.

ach near the cardia and œsophagus, at the greater curvature, especially at the pylorus and between the stomach and colon and in the omenta, are not infrequent at one or more situations in these cases.   If extensive glandular enlargement or adhesions are present, gastro-enterostomy should be done instead of pylorectomy.

The Isolation of the Pylorus.—Raise the diseased tissues carefully into
the wound as far as practicable, and note again the extent of the morbid
process; separate the greater and lesser omenta from the stomach and duo-
denum by means of ligatures and scissors carried as close to the structures
as is consistent with proper removal of the disease (Fig. 1134); lift the
isolated tumor still farther into the wound and pack around it hot, dry
aseptic gauze or sponges so completely as to prevent the possibility of infec-
tion of the abdominal cavity and exposed peritonæum; clamp the duo-
denum close to the edge of the tumor and outside of this point (Fig. 1135),
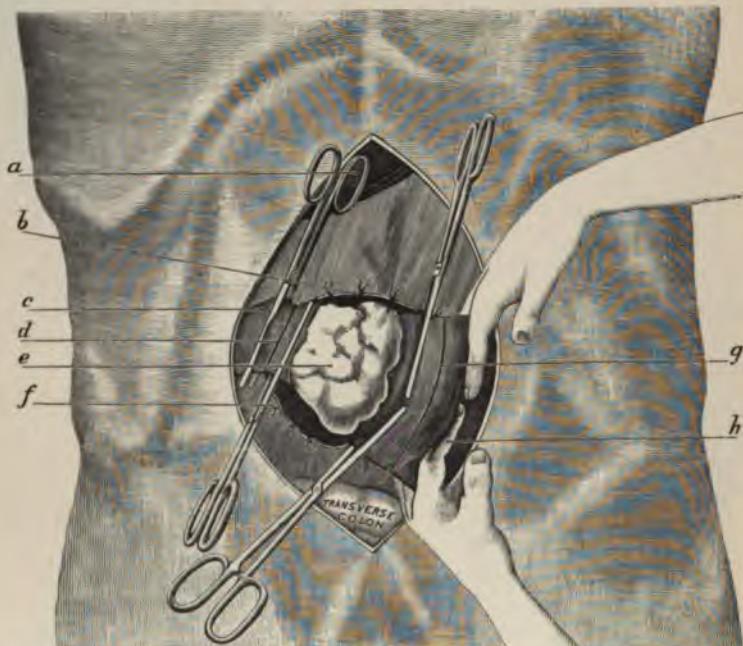
Fig. 1135.—The operation of resection of the pylorus, first stage, Kocher's method.
a. Liver. *b.* Line of severance of lesser omentum. *c.* Duodenum. *d.* Line of divi-
sion of duodenum. *e.* Diseased mass. *f.* Line of severance of greater omentum.
g. Line of division of the stomach. *h.* Fingers of assistant acting as compressing
agents.

and also the stomach at the cardiac side of the tumor, with one or more
forceps or by other suitable means, after pushing aside the contents.

The Remarks.—The diseased portion should be raised well out of the
abdominal cavity in order to permit of as complete extra-peritoneal opera-
tion as possible. The severance from the stomach of the greater and lesser
omenta extends a little beyond the diseased area (Fig. 1135, *b, f*), and is
accomplished by double ligatures of chromicized gut, or by silk applied to
isolated portions of the omental tissue by means of an aneurism needle or
Cleveland's ligature carrier (Fig. 1131, *j*). The width of the portion
grasped by the respective ligatures will be governed by the thickness of the
tissue and the size and number of its vessels, remembering to include only

the amount that can be securely tied. The illustration (Fig. 1135) indicates approximately the number of and distance between the ligatures.

FIG. 1136.—The operation of pylorectomy, showing lines of division at either limit of disease. *a*. Transverse division of duodenum. *b, c*. Transverse and oblique divisions of the stomach.

The Resection of Diseased Tissues (Fig. 1135).—Sever the duodenum with scissors and thoroughly disinfect the distal end and wrap it in sterilized gauze and turn it outward with the forceps (*a*); wrap the proximal end in moistened, sterilized gauze and raise the tumor upward still farther; cause the assistant to grasp the stomach at each border beyond the line of proposed section with the thumb and index finger of each hand, or with the index and middle fingers of the same (Fig. 1135, *h*); surround the stomach at the seat of proposed section and the hands of the assistant holding it with an abundance of sterilized gauze; with scissors divide the stomach parallel with the clamp, arresting the bleeding points with forcipressure as they appear; remove the tumor, wipe away all infecting agents that may

FIG. 1137.—Pylorectomy for carcinoma of the pylorus. Transverse division.

FIG. 1138.—The operation of pylorectomy. Duodenum implanted at center of pyloric division.

have escaped, and ligature the important vessels.   The union of the viscera
may be made in two ways—i. e., directly as immediately follows, or indi-
rectly, pylorectomy with gastro-enterostomy, as practiced by Kocher (Fig.
1143), and properly the completion of the operation just described.

The Remarks.—The division of the walls of the stomach is modified
somewhat by the outline of the disease, the aim being to follow this outline
as nearly as may be consistent with expedient repair; a healthy margin of
not less than half an inch should always be removed at either extremity of
the disease.   Both walls of the stomach should be divided along similar
lines, unless too great sacrifice of healthy tissue be the result of this action.

The lines of section are the transverse and the oblique (Fig. 1136), the
latter being single or double (Fig. 1136).   The single oblique line begins
at the greater curvature and extends upward toward the cardiac or the
pyloric end of the organ, as the location of the disease may require.   The
double oblique line of division is applied to the upper and lower portions of
the main incision, so as to establish an extremity that will properly fit the
distal end of the duodenum (Fig. 1138).

The Joining of the Intestine and Stomach.—The seat of insertion of
the duodenum being determined, the remaining part of the gastric wound

Fig. 1139.—The operation of pylorectomy.   Duodenum implanted at line of lesser
curvature.

is promptly closed by one of two methods of sewing: 1. By means of an
overhand continuous silk suture, carried up to the point of duodenal im-
plantation, followed by inversion of this line of sewing by continuous or
interrupted Lembert or Halsted suturing carried so as to include the sub-
mucous fibrous coat. 2. By union of the mucous coats with a continuous
suture, supplemented by a double row of Lembert sutures carried through
the sero-muscular coats, or the second row need include only the serous
coats.   The former plan is employed by Kocher, only continuous sutures
being used (Figs. 1009 and 1010).   This plan is certainly the most expe-
ditious, and is equally secure.   In the instance of transverse division of the
stomach the duodenum is implanted at the upper or lower portion of the
wound as best meets the requirements of the case (Figs. 1139 and 1140).
If the stomach be much dilated, the duodenum should be joined close to
the greater curvature (Wölfler) (Figs. 1108 and 1109).

The Remarks.—The cavity of the stomach should be mopped dry, and sponges with strong attachments introduced for support and cleanliness, being removed as the closure progresses. Curved needles for sewing the inner, and straight for union of the outer surfaces, are the best. The avoid-

Fig. 1140.—The operation of pylorectomy. Duodenum implanted at line of greater curvature.

ance of folds or puckering of the line of union is essential to its security. The suturing together of the divided borders is facilitated by partial section and sewing instead of complete division before suturing, for thus better command of the parts is secured and more rapid and effective work performed; also, leaving some of the sutures long for clamping and support assists materially in the union of the parts. The joining of the parts by simple sewing is a longer though more substantial method of procedure than by means of mechanical expedients. Therefore, the condition of the patient and the experience of the operator count for much in the selection of the best means of union in individual cases. Absorbable tubes and bobbins and Murphy's button are the mechanical expedients which are regarded as serviceable substitutes for sewing, on special occasions. *Greig Smith* regarded the absorbable tube as the best agent of union in those cases in which the disease is of a limited extent and involves the duodenum rather than the stomach, and in which the divided borders of the viscera can be approximated without undue traction. A curved decalcified bone tube (Fig. 1141) with a broader gastric and a narrower intestinal end, provided with an intervening transverse groove with

Fig. 1141.—The operation of pylorectomy. Apposition of duodenum with stomach by sutures over decalcified bone tube.

perforations, is fastened and held in place by purse-string suturing at both openings, followed by union of the free borders by a continuous suture. Each of the preceding methods is much more dangerous than either of the following, and should not be substituted therefor.

Pylorectomy combined with Gastro-enterostomy.—This combination of methods is employed especially when divided borders can not be united with

each other in the stereotyped way after the removal of the morbid growth. *Kocher* regards it as superior in many respects to the older plan even in cases suited to the latter, and practices it almost exclusively. *Czerny* favors reversal of this order of procedure by the doing first of posterior
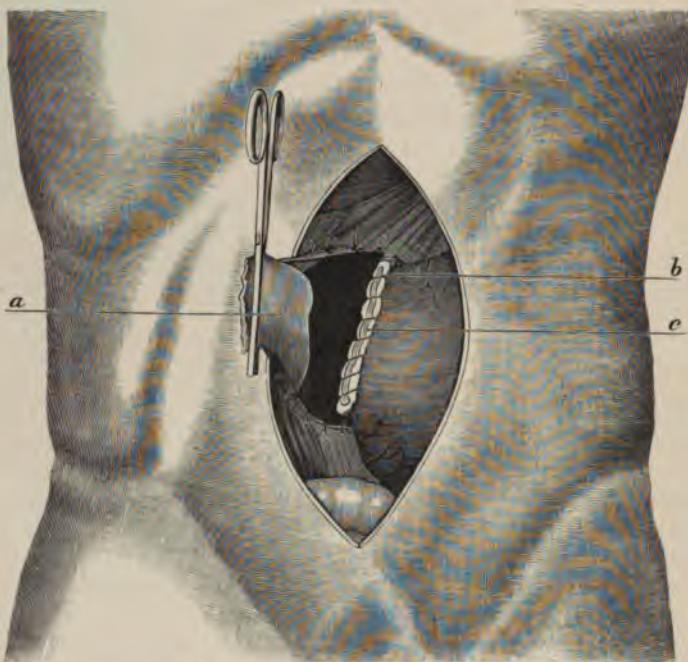
Fig. 1142.—The operation of resection of the pylorus and gastro-enterostomy, Kocher's method. *a.* Duodenum. *b.* Border of stomach sutured by a continuous suture penetrating all of the coats. *c.* United borders of the mucous membrane of the stomach.

gastro-enterostomy, followed by resection of the growth and closure of the stomach and duodenum. *Kocher* closes the wound in the stomach entirely by an overhand continuous silk suture carried from the greater to the lesser curvature of the stomach through all the coats (Fig. 1142). Then, after cleansing the united borders, the primary row is invaginated and covered in by a second row of continuous Lembert sutures carried through the sero-muscular walls only. After all infecting agents are removed and the parts thoroughly cleansed, and the assistant has grasped the stomach with both hands and pressed it to the right (patient's) so as to close the duodenum (Fig. 1143), liberate and cleanse the duodenal end, close the duodenum with forceps and apply the end to the stomach so as to permit of a ready union to each other of the posterior walls of the viscera, by means of a long continuous silk suture (*b*) the ends of which remain free; make an incision into the stomach (*e*) one fourth of an inch above the line of sewing corresponding in length to the width of the duodenum; arrest hæmorrhage, and unite the borders of the respective organs with each other on the side already attached by a continuous suture carried through

the walls, or by a continuous one carried through the mucous membranes only, and on the opposite side by a sero-muscular continuous suture; arm the long, free extremities of the primary posterior suture with needles, and therewith supplement the anterior line of sewing with a final continuous row, including the serous coats only; thoroughly cleanse the parts, especially the line of suture; remove the protecting gauze, replace the organs, and close the abdominal wound.

The union can be accomplished more quickly by Maunsell's method (Fig. 935), or by the absorbable tube, or the Murphy button.   Both duodenal and gastric openings can be closed and the union made at the posterior surface either by 1, direct sewing; 2, Murphy's button; 3, tubes and bobbins.   If the space between the viscera be too great for their proper apposition, the jejunum can be joined with the stomach in the manner already described (gastro-enterostomy).   The method of procedure employed should be selected with due regard for the beneficent influence of
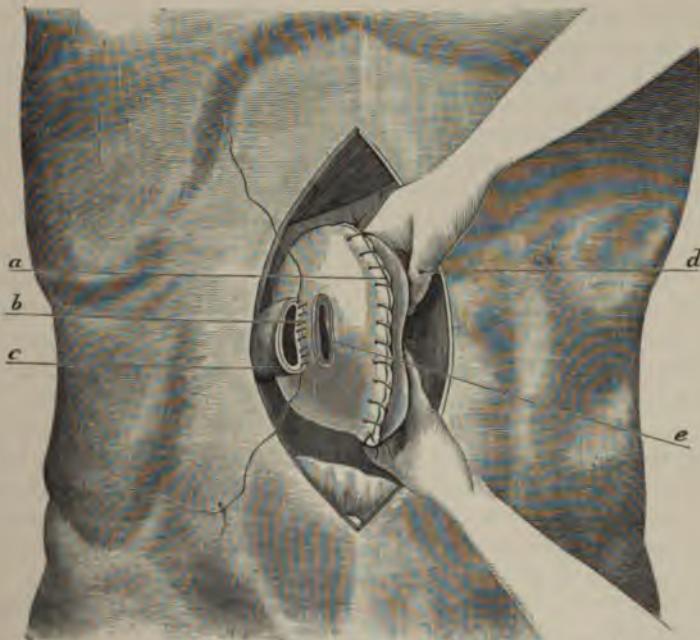
FIG. 1143.—The operation of pylorectomy and gastro-enterostomy, Kocher's method. *a.* Continuous serous suture closing the stomach. *b.* Post-serous suture between stomach and duodenum. *c.* Duodenum. *d.* Assistant closing stomach and duodenum by pressure. *e.* Opening in posterior wall of stomach.

promptness of execution and of experience on the immediate and future outcome of the case.

The Precautions.—Digital, instrumental, sponge and textile fabric temporary closure of the openings of the divided viscera are each advised and practiced with care, to prevent peritoneal infection. The retention of a sponge or of gauze in the stomach after final closure of the wound should

be avoided (page 926). The underlying vessels must be carefully guarded during separation of the tumor, and the connecting tissues separated and tied singly or doubly as suits the circumstances of the case. The transverse mesocolon should be respected, as injury of it may result in impaired circulation and gangrene of the colon. And, too, gangrene of the colon may follow division of the omentum at the greater curvature of the stomach (Fig. 1134, *a, a*). Deep and abundant gauze or sponge packing is imperatively demanded to prevent peritoneal infection. Small strips of oiled iodoform gauze carried around the line of suture and allowed to escape at the external wound, and remaining for two or three days until danger of leakage has passed, may be employed (page 856). The introduction into the abdomen of sublimate or similar solutions should rarely be practiced, as the use of absorbent gauze and hot saline solutions are equally serviceable and much less dangerous.

The length of time required in many operations on the abdominal contents, together with the frequent great debility of the patient, bespeaks a wise selection and the cautious use of anæsthetics. Chloroform is less often followed by vomiting than is ether. Nitrous oxide in abdominal operations requiring extended and careful technique is highly objectionable because of the frequent inability to control the spasmodic movements attendant on its use. However, the primary administration of nitrous oxide in any operation for the amelioration of or relief from some of the objectionable effects of ether is a matter of quite common practice in large towns and in hospitals, and offers patients an escape from the primary irritation and some of the annoying after-effects of this anæsthetic. A more extended employment of local anæsthesia from weak solutions of cocain, eucain, holocain, etc. (page 36, vol. i), is to be encouraged. In fact, much of the work on the human viscera can be carried on without anæsthesia with but little annoyance to the patient. The administration of morphin hypodermically during the latter part of an operation under ether anæsthesia permits the practice of much of the minor and final steps of an operation without further use of ether, thus shortening considerably the period of ether administration (page 24). The free utilization of the hot saline solution in the prevention and treatment of shock by injection into the cellular tissue of the breast, thigh, etc., and into the veins in urgent cases, is of significant importance in abdominal operations (page 121, vol. i).

The Remarks.—Pylorectomy for malignant disease is contraindicated when contiguous tissues are involved and secondary deposits are present, especially when attended with restricting adhesions. Infected glands and other limited involvements should be removed when practicable. The ability to outline the tumor *before* laparatomy is strongly suggestive of an unfavorable outlook; the reverse can be regarded with favor. Therefore, the scope of preparation for operation should comprehend the accepted methods of surgical relief for the conditions as they may appear on exposure. Thorough cleansing of the stomach and rectal stimulation are the essential elements of routine practice. Rectal alimentation alone should be practiced for the first two or three days after the operation, if the patient's condition will permit. In the instance of the use of the Murphy button, gastric

feeding may begin at an earlier date. The incisions into the viscera should correspond with each other in direction and extent as nearly as practicable, to facilitate prompt union and avoid distortion. Distorted implantation and joining of the duodenum with the stomach and irregular union of divided borders should be sedulously avoided; all should be joined in their natural outline with great care. The raising and removal of a V-shaped flap from the stomach composed of the sero-muscular coats only, for the purpose of narrowing the gastric opening, followed by suturing of the divided tissues with each other, with inversion of the undivided mucous coat, is recommended as a safer and prompter plan of action than a complete division for the purpose (Billroth). In circular union the internal employment of sutures is better than the external, and should be practiced as far as is possible, the remaining portion being closed and the entire line fortified by one or two rows of external sutures. About one third of the line of implantation can be united by the internal sewing (Fig. 917) (Wölfler). Twenty-five or thirty round, straight cambric needles, each armed with Chinese silk, should be prepared before commencement of the operation (Fig. 1131, p). Delay in procedure for the purpose of threading needles is an inexcusable sacrifice of time and human vitality. *Kocher* regards a continuous suture carried entirely through the borders of the wound as the best primary suture for security, control of bleeding, and expeditious work; and further, that *the use of clamps* adds to the safety, facility, and dispatch in operation, and believes that no danger comes to the tissues from their use when they are applied only with needed firmness. Jessett advised the ligature of the main arteries of the greater and lesser curvatures of the stomach (Fig. 1132) just outside of the limits of the disease, thus so controlling the circulation of the omenta as to permit the ligature of large segments of the greater and tearing through of the lesser omentum, hastening thereby resection. *Kocher*, by his combined method, operated on 23 cases, with 2 deaths. *Lücke* had 7 consecutive recoveries by same means.

The Results.—Shock and perforative peritonitis are the most frequent causes of death associated with the operation. In pylorectomy, when performed for non-malignant disease, 8 per cent died from the operation; for malignant disease, 25 to 53 per cent, according to different estimates. In 59 cases of recovery the average length of life was eleven months and four days (Richardson). Of 130 cases done prior to 1892, the rate of mortality, as based on the extent of the adhesions, varied as follows: No adhesions, 50 per cent; slight adhesions, 60 per cent; and numerous adhesions, 97 per cent (Schramm). According to later estimates, with no adhesions the rate of mortality was 27.2, and with extensive adhesions 72.7 per cent (Wölfler). Even better results than these are stated in rare instances in the experience of renowned operators. *Mikulicz,* 10 cases, 1 death. *Krönlein,* 29, with 2 deaths.

Mayo practices this operation in the following prompt and efficient manner: * He divides the procedure into six stages:

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* Annals of Surgery, March, 1904.

The Operation—The First Stage.—Make an incision in the median line, halfway between the ensiform and the umbilicus, of sufficient length to permit of the introduction of two fingers for exploratory purposes; close the incision at once (if case be inoperable) with buried non-absorbable sutures, thus permitting the patient to be about at the earliest possible moment; rapidly enlarge the opening to four or five inches (if operation is to be done), draw the borders of the wound apart, exposing the gastro-hepatic
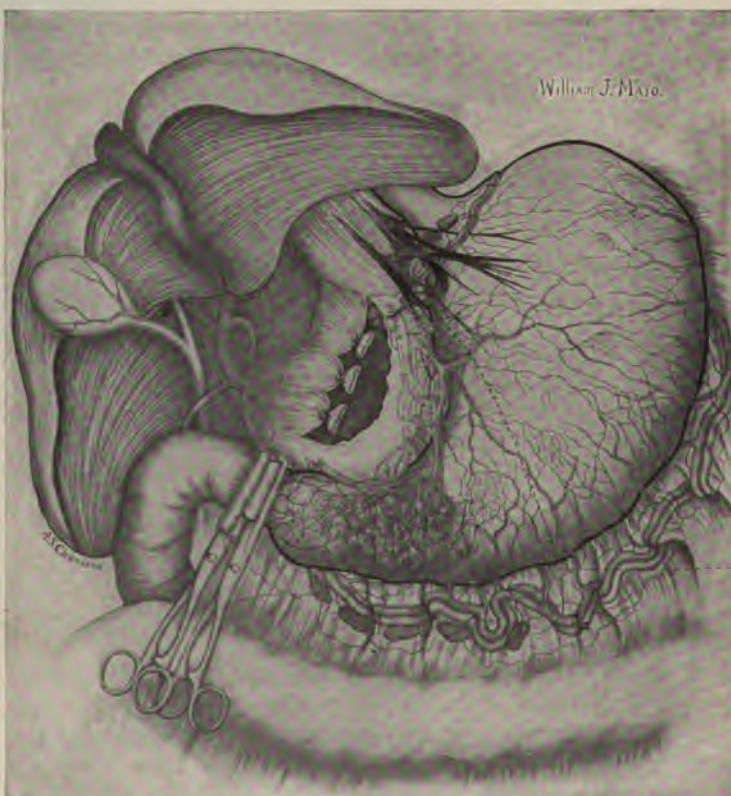
Fig. 1144.—Mayo's method in pylorectomy. The dotted line showing line of incision of stomach. Ligature of vessels at greater curvature. Gastro-hepatic omentum ligatured and severed, duodenum clamped. (See lymph nodes in Fig. 1133.)

omentum; tie off sufficient of this omentum to escape the tumor, close to the liver, thus opening the lesser sac (Fig. 1144), pack off the entire area with gauze pads.

Second Stage.—Tie between two ligatures the gastric artery at a point below the cardiac opening, where it reaches the lesser curvature; tie between two ligatures and divide the pyloric artery as it reaches the stomach; pass the fingers beneath the pylorus and raise the gastro-hepatic omentum from the transverse mesocolon and ligature behind the pylorus the

gastro-epiploica dextra or gastro-duodenal artery; tie the gastro-epiploica sinistra and the proper amount of gastro-colic omentum between two ligatures and divide them between the ligatures.

The Remarks.—When the right margin of the omentum becomes congested from venous obstruction incident to ligature, it may be wise to remove it to prevent death of the part. Care should be taken not to include the colica-media when ligaturing the gastro-colic omentum, since gan-
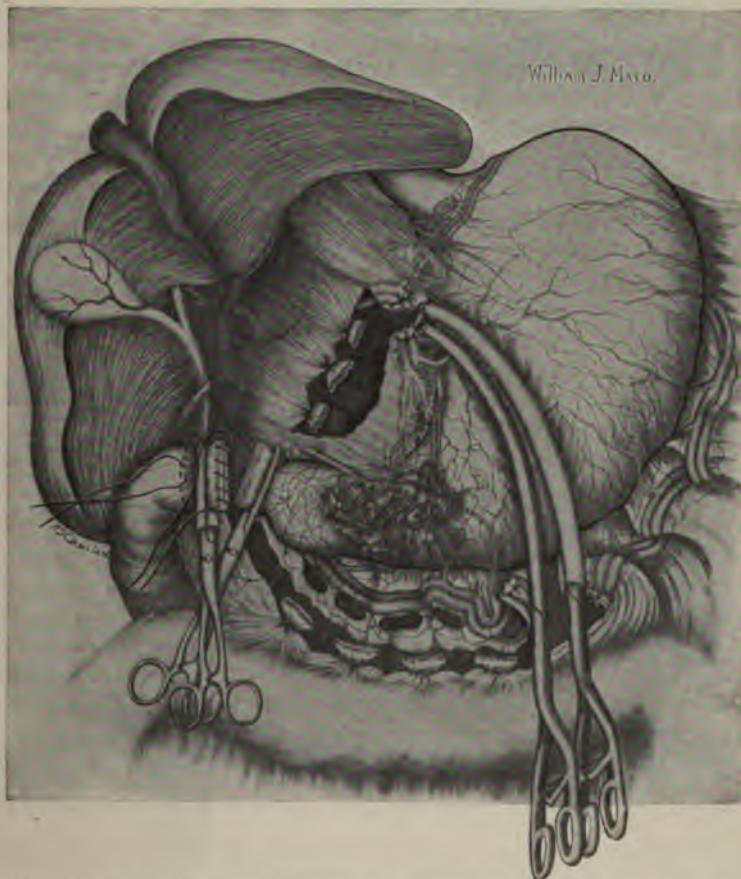
FIG. 1145.—Mayo's method in pylorectomy showing gastro-colic omentum ligatured, duodenum clamped, severed, and sewed. Stomach clamped for incision. (Compare with Fig. 1133.)

grene of the colon will follow. Ligaturing the vessels as indicated renders the operation almost bloodless.

Third Stage.—Doubly clamp the duodenum and sever it with cautery, a fourth of an inch from the outer blade, and follow by a running suture of catgut and removal of the clamp; introduce a purse-string suture three quarters of an inch below the stump, turn the stump inward, tighten and tie the suture (Fig. 1145); grasp with a Kocher clamp the stomach from

the point of ligature of the gastric artery above, obliquely, saving as much as possible of the greater curvature; apply a second clamp at the site of the tumor to prevent leakage, and sever the stomach with cautery a quarter of an inch from the first clamp, catching the border of the stump in several places, to prevent retraction of the walls from the grasp of the forceps; remove the severed portion of the stomach without leakage and sew the border from the greater curvature to the lesser and back, with a cat-gut button-hole suture (Fig. 1146), thus preventing hæmorrhage and
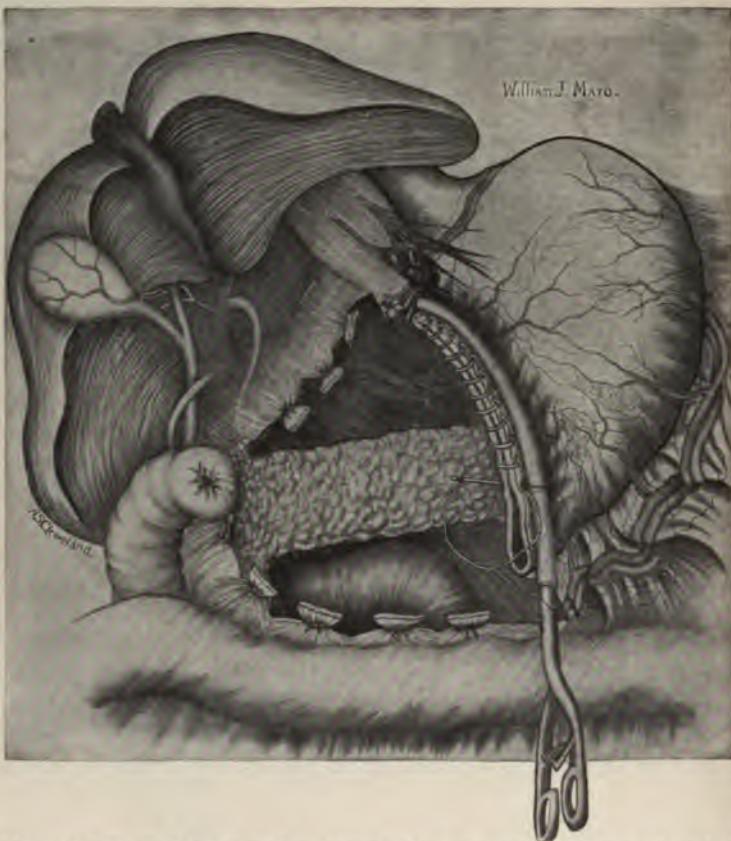
Fig. 1146.—Mayo's method in pylorectomy. Showing pylorus removed and stomach being sutured with clamp in position. Duodenum completed.

leakage; remove the clamp, catch all bleeding points and turn in the line of suture by Cushing's right-angle stitch without undue tension (Fig. 910).

The Remarks.—Mayo frequently ties off the gastro-hepatic omentum and superior vessels, doubly clamps and divides the duodenum, thus readily exposing the gastro-duodenal artery for ligature. Less frequently he has begun on the sound end of the stomach, ligaturing and dividing the gastric and gastro-epiploica sinistra vessels first. The first plan is regarded by

Mayo as the better, especially when adhesions are present, affording more accurate work and better exposure of the parts.

The Fourth Stage.—This step consists in the performance of gastro-jejunostomy by the posterior suture method or the anterior Murphy button method, depending on the time at the disposal of the operator (Fig. 1147).

The Fifth Step.—This step consists in guarding against infection by means of gauze pads, deep and superficial layers, the former not being disturbed during operation, the latter frequently changed. The use of the

Fig. 1147.—Mayo's method in pylorectomy. Showing disease removed and gastro-jejunostomy finished.

clamps and of cautery prevents pyogenic and malignant infections respectively. Careful scrutiny for the detection of bleeding points and cleansing of the operative field is followed with closure of the wound without drainage, except in the instance of doubt regarding infection, when drainage is introduced.

The Sixth Step.—If the patient be in good condition little or no shock attends the operation. But if, as is too often the case, the patient be in a poor condition, shock attends and should be treated in the usual manner. *Allen* suggests as a preventive, spontaneous saline injections of twenty or

64

thirty ounces twice per diem, for two or three days preceding operation, thus replacing the fluids removed by the diseased process.

The Remarks.—Patients with cancer of the stomach should be gotten out of bed as soon as possible to prevent still greater depresssion.

After-treatment.—Place patient in bed with head and shoulders raised on pillows. Rectal alimentation, hot water by the mouth for twelve hours in tablespoonful doses, increased to an ounce each hour, at the end of thirty-six hours, may be continuously administered.

The Results.—Mayo reports 41 personal radical operations on the pylorus; 37 for cancer and 4 for ulcer. Of 13 done in the manner just described, one died. Of the remaining 28 done by different methods, 6 died. In the last eleven of the 28 operated on by the preceding plan, no deaths occurred.

Pyloroplasty (Heineke-Mikulicz).—The term pyloroplasty is applied to the operation for the relief of stenosis of the pyloric orifice of the stomach resulting from non-malignant, morbid changes. Preparatory washing out of the stomach need not be practiced, if to do so will cause much distress to the patient, as the contents of the stomach can be made to gravitate to the cardiac end by attention to the position of the patient. In other respects the preparatory and precautionary measures of stimulation and asepsis, which are addressed to abdominal operations for debilitating disease, should be carefully practiced.

The Operation.—Make an incision in the median line between the sternum and navel two to four inches in length; draw apart the borders of the wound with traction sutures; raise the pylorus into the wound with the thumb and fingers, separating or stretching by gentle traction any opposing adhesions; isolate the pylorus from contiguous structures by abundant sponge or gauze packing so completely as to prevent the possibility of peritoneal infection from escaping fluids; make a longitudinal incision through the anterior wall of the stomach, midway between the upper and lower borders, close to the pylorus, sufficiently large to admit the index finger; pass the finger through the opening into the pylorus to ascertain the presence and degree of the obstruction; remove the finger

Fig. 1148.—The operation of pyloroplasty, the Heineke-Mikulicz method, showing longitudinal incision of structure.

and extend the incision outward directly through the diseased parts into the healthy duodenum (Fig. 1148); draw apart the borders of the wound with traction sutures carried through the entire thickness of the walls at the middle of either side of the wound, thus changing the outline of the wound from a longitudinal to a transverse direction; introduce the stitches as indicated in the cuts (Figs. 1149 and 1150), and, if practicable, omit the tying until all are in place; add to the interrupted row of sutures a supplementing continuous one directed to the serous coat only; cleanse and return the parts to the normal

site; remove the packing and close the abdominal wound in the usual manner, if desirable.

The Remarks.—The length of the entire incision is about two inches. The tissues of the borders of the incision may be so rigid as to require quite vigorous manipulation to change the direction of the wound and properly appose the borders. Splitting the borders of the hypertrophied tissues along the line of incision so as to form a musculo-mucous flap within and a sero-muscular one without, and uniting the inner ones together with continuous catgut and the outer with continuous or interrupted silk sutures, is advised by *Greig Smith* in cases with densely thickened borders. If the structure be
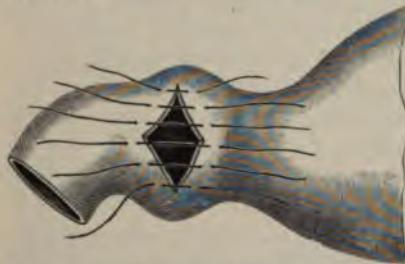

FIG. 1149.—The operation of pyloroplasty, the Heineke-Mikulicz method, showing sutures placed for transverse approximation of the longitudinal incision.

FIG. 1150.—The operation of pyloroplasty, the Heineke-Mikulicz method, clearly showing union of borders and increased capacity of duodenum.

exceedingly dense and unmanageable, the incision through it may be made of a diamond shape followed by removal of the included part. This course makes the transverse coaptation easier, as can be readily seen. *Greig Smith* regards the use of the absorbable tube in the lumen of much weight in the cases complicated with rigid walls of limited extent, and advises that the mucous and the remaining coats be sewed by a continuous suture independently of each other. He regards this appliance as important, because it furnishes an opening from the outset and prevents constriction during healing. Oozing only should be controlled by sewing; other forms of bleeding by ligature. If infection of the wound has taken place and doubtful cleansing be suspected, complete closure of the abdomen should be suspended and iodoform-gauze tents inserted for two or three days, after which they are removed and the abdomen closed.

Finney's Method.*—*The preparatory treatment* consists in cleansing the teeth and mouth with carbolic solution for two or three days before operation and the giving of sterile food and drink, with irrigation of the stomach the night and morning before the operation with boiled water.

The Operation.—Make the abdominal incision through the right rectus, six or eight inches in length, to secure abundant room for prompt action; carefully protect the operation field by a liberal use of suitable pads; introduce a traction suture into the upper wall of the pylorus (Fig. 1151, first step); introduce a second into the anterior wall of the stomach, and a third into the anterior wall of the duodenum, each 12 c.m. (about five inches)

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* Bulletin of Johns Hopkins Hospital, July, 1902.

from the first one introduced, thus indicating the lower ends of the pro-
posed duodenal and gastric incisions, respectively; make the tissues tense
by pulling upward on the pyloric loop and downward on the remaining
two; suture together with a continuous suture (or mattress) as far pos-
teriorly as possible along the greater curvature, the peritoneal surfaces
of the stomach and duodenum (Fig. 1151, second step); introduce an ante-
rior row of sutures (mattress) (Fig. 1151, third step); leaving the ends
long and untied; collect the free ends together, grasp them with a forci-
pressure and draw them upward, also separate the intervening portions in
either direction by hooks, so as to freely expose for incision the underlying
tissues as indicated in the cut (Fig. 1151, fourth step); make a horse-
shoe-shaped incision between the sutures, as shown, into the viscera con-
cerned in the operation; arrest bleeding and carry a continuous catgut
suture through the borders at the posterior side of the incision (Fig.
1151, fifth step), thus securing better apposition of the cut edges of the
mucous membrane; arrange properly and tie the anterior line of sutures
already placed, thus completing the operation unless additional Lembert
sutures in front be desired (Fig. 1151, final step).

The Comments.—The size of the opening can be made to correspond to
the demands of the case. Adhesions holding the pylorus in abnormal posi-
tions should be overcome as fully as possible, as the success of the opera-
tion depends largely on the freedom of the structures at the pyloric end of
the stomach. The following objections to the Heineke-Mikulicz operation
(except the second) are thought to be overcome by this method:

1st. Its inapplicability in cases of extensive and firm adhesions about
the pylorus.

2d. Its inapplicability in the presence of semi-active ulceration.

3d. The liability to recurrence of the stricture due to contraction of
the scars.

4th. The inability to obtain good apposition on account of the rigidity
of the walls of the stomach and duodenum.

5th. The outlet of the stomach is not placed at the most dependent
portion, hence in the presence of motor insufficiency the aid of gravity, in
emptying the stomach is lent. Scar tissue may be removed during oper-
ation.

The After-treatment.—Nothing should be given by mouth for the first
thirty-six to forty-eight hours; for the first twenty-four, enemata of salt
solution and coffee are given every five hours, after which they are alter-
nated with nutritive enemata and on the second and third day albumen in
teaspoonful doses is given, followed by broths and milk if well borne.

Patients are encouraged to turn from side to side and to be propped up
in bed quite soon.

Finney reports five cases of his own, four of which were entirely satis-
factory, and one of a too recent date to speak of the final outcome.

The General Results.—The general rate of mortality of the operation
is about 21 per cent. Better results than this (7 per cent, Carle) are re-
ported at a late date. The final outcome, though not entirely satisfactory,
is much superior to that of divulsion of the stenosis. Formerly the sim-

First step.

Second step.

Third step.

Fourth step.

Fifth step.

Final step.
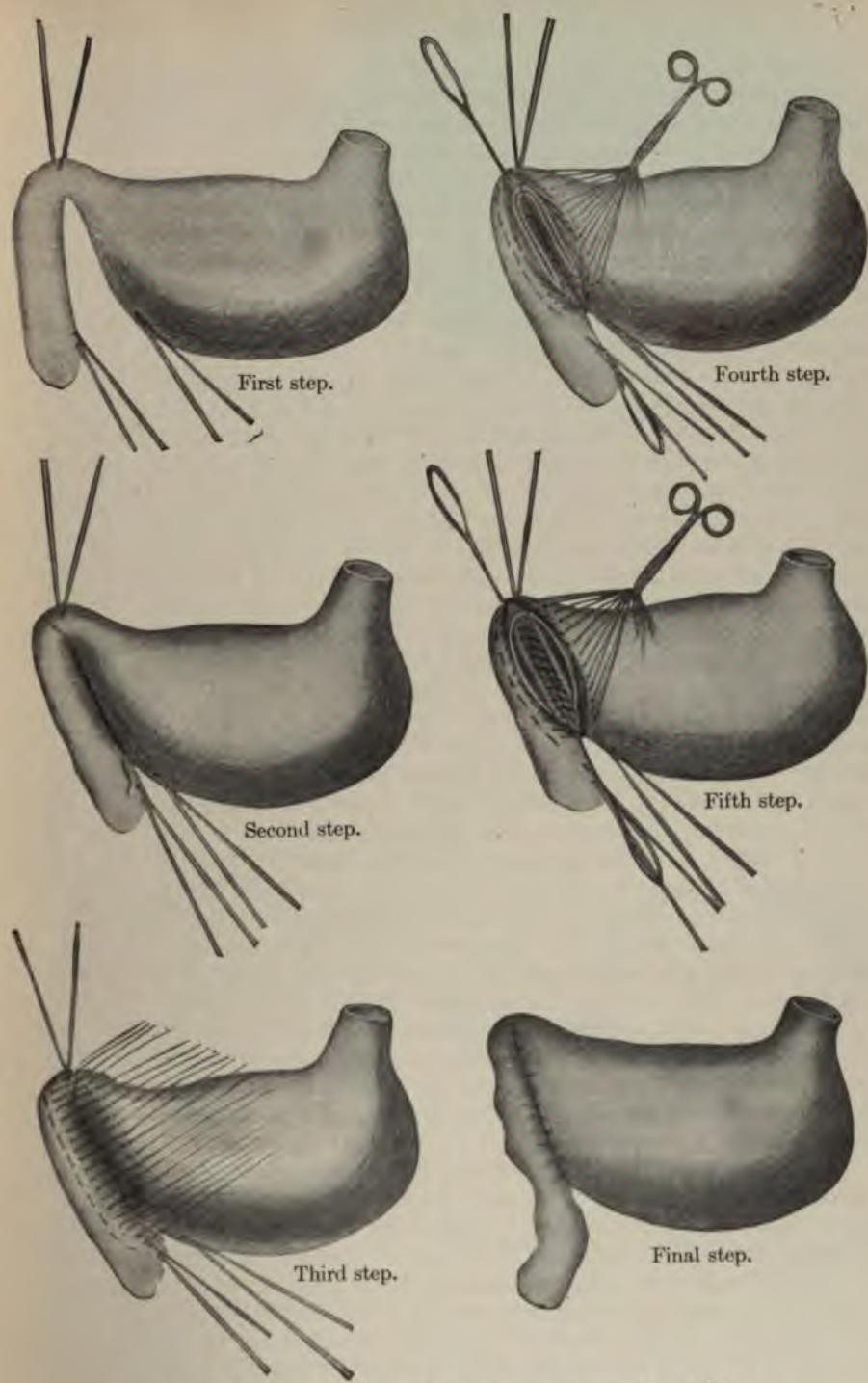
Fig. 1151.—The operation of pyloroplasty, Finney's method.

945

plicity of the operation and its comparatively low rate of mortality com-
mended highly the practice, but the latter development of gastro-enteros-
tomy supplemented by the Murphy button, and the fickleness of the relief
of the former, have lessened its favor with most surgeons.

Divulsion of the Pylorus (Loreta).—*Loreta's* operation is applicable to
non-malignant stenosis only, and can be accomplished by digital or instru-
mental force.

The Operation.—The operation is similar in all essential points to that
of pyloroplasty until after the stomach is incised longitudinally or vertically
inside the seat of the stricture. Then introduce the index and middle
fingers of the right hand into the stomach; push slowly and with care
through the stricture the end of the middle finger, steadying the pylorus
with the thumb and finger of the left hand applied without; raise upward
the pylorus with the middle finger and insinuate cautiously the index
finger by the side of the middle, carefully observing if dangerous tension
be made on the outer coats of the gut; introduce the ring finger care-
fully by the side of the two already inserted, if the act be consistent with
the maintenance of the integrity of the wall of the viscus; withdraw the
fingers from the strictured part in the order introduced, and, after a brief
period, reinsert in like manner as before, noting if undue resiliency of the
stretched tissues be present. If the caliber remain dilated to a proper degree,
withdraw the fingers from the stomach. If undue resiliency cause objec-
tionable closure, further stretching is made by a reintroduction and separa-
tion of the fingers before the final withdrawal. On withdrawal of the
fingers, observe through the opening if active bleeding of ruptured tissues be
present. If so, introduce into the dilated channel the index finger, while
covered with aseptic gauze saturated with a hot sterile saline solution, and
hold it there for a time while firm circular compression is made upon it
from without. After the arrest of bleeding, close the opening into the
stomach by sewing in the manner usual in sero-muscular strictures. Re-
move the packing, cleanse the parts, and close the abdomen carefully, unless
fear of infection sanctions the temporary use of gauze tents. The final
dressing is then applied, and the patient nourished by the bowel for the first
three or four days, after which light fluid food in small amounts is given
by the mouth; solid food is not taken before the tenth or twelfth day. In-
strumental dilatation offers no advantages over the digital, unless the stric-
ture be too small to admit the end of the finger. In such cases the use of
instruments should precede that of the fingers and cease when the finger is
safely available for the purpose.

The Remarks.—The normal pyloric orifice will admit quite readily the
extremity of an ordinary sized index finger. The pylorus may be bound
down more or less immovably by adhesions and somewhat obscured by
diseased structural changes. The gastric incision is made vertically
or longitudinally; the former is thought to be attended with less hæmor-
rhage and is made by cutting with scissors a longitudinal fold, raised with
the thumb and fingers. Complete isolation of the pylorus from the perito-
neal cavity by gauze or sponges should precede the opening of the stomach.

The Precautions.—The usual precautions against infection from the

escape of gastric fluids must be practiced. Force should be cautiously employed and the pyloric structure carefully observed to detect the presence of ruptures, which should not be lightly treated. All hæmorrhage should be arrested and lacerations repaired by sewing before final closure of the abdominal wound. Cautious dilatation is necessary, as in some instances unsuspected tissue changes may permit extensive rupture as the end of the finger is being forced into the stricture. If the stomach be greatly dilated, the location of the pyloric opening may be difficult and perhaps impossible. In this instance pyloroplasty or, preferably, gastro-enterostomy should be practiced at once, if the patient's condition will permit; if not, gastrostomy, with subsequent gastro-enterostomy should be considered. The attempt to force the end of the finger through a too small constriction should give way to the primary use of a small catheter or bougie, for obvious reasons.

The Results.—Hæmorrhage, rupture, and shock are common causes of death from the operation. Return of the stricture is always to be feared, the same as in urethral stricture when treated on similar principles. Obstructive symptoms have returned in rare instances within a week after the operation. The general rate of mortality appears to be from 33.3 (Kinnicutt and Bull) to 40 per cent (Barton), which seems much too high for the apparent magnitude of the operation. At all events, the high death rate and the uncertainty of cure do not inspire unbiased judgment in its favor, especially when pyloroplasty, and, better still, gastro-enterostomy, are alternatives.

Dilatation of the Cardiac Orifice.—Dilatation of this opening has been practiced not infrequently with success for the relief from stricture there and also at the lower part of the œsophagus. The description of the technique will be found under the treatment of œsophageal stricture (page 672, vol. i).

Gastroplasty. — In gastroplasty the principles and methods of action utilized to overcome the constricted portion of the stomach are identical with those employed at the pylorus for a similar purpose.

The Operation.—Make an incision through the anterior wall of the stomach, in the long axis of the deformity, extending an inch or so beyond the limits of the constriction at either end (Fig. 1152); convert this incision into a trans-

Fig. 1152.—The operation of gastroplasty. *a.* The incision. *a′.* The union by transverse apposition.

verse incision by bringing together the ends (Fig. 1152, *a′*) with the mattress suture. Cases not amenable to this measure can be treated by gastrogastrostomy, gastro-enterostomy of either or both pouches, and by partial gastrectomy (Fig. 1153).

The Remarks.—If easy adjustment can be made, a continuous suture, including all of the coats of the stomach, may be introduced, followed by a sero-muscular superficial one.

It may be necessary to dissect away some of the cicatricial tissue in order to properly adjust the borders. The freer the incision the less is the liability of subsequent contractions.

The Remarks.—Watson reports 17 cases, with 3 deaths.

Gastro-gastrostomy (*Gastro-anastomosis*).— Gastro-gastrostomy is practiced for relief from the infliction of hour-glass contraction of the stomach. *Wölfler*, through an incision in the median line and with aseptic precautions, exposed the deformed stomach, and made an opening of ample size to afford ready transmission of the contents of the organ into each of

FIG. 1153.—Partial gastrectomy for deformity of stomach.

the pouches, corresponding as nearly as practicable to the greater curvature (Fig. 1154). He united together the corresponding borders of the openings by means of his characteristic method of sewing (page 757, Fig. 916) similar viscera, and thus relieved the patient from the effects of the infirmity.

FIG. 1154.—The operation of gastro-gastrostomy, Wölfler's method, showing the corresponding openings.

FIG. 1155.—The operation of gastro-gastrostomy, Wölfler's method, showing suturing of the borders of the openings.

The Results.—Apparently six instances of this method of practice are noted, all but one of which recovered from the operation, and remained well some months subsequently.

Watson, at a more recent date and in a more decided case of contraction (Fig. 1156), practiced the following plan: The two pouches were folded upon each other, and the corresponding borders of a limited area of the apposed surfaces were sutured together (Fig. 1157), the sutures at each end of union remaining long to indicate the lines of sewing (*f, f, f*). The anterior wall of the anterior pouch was then incised longitudinally (*g, g*) at a point opposite to the previously united surfaces, thus affording opportunity for division of the contiguous walls of the apposed pouches at a point within the circumscribed area of sewing. The anterior incision was then closed, the remaining extremities of the long sutures were cut off short, and the borders of the abdominal wound united in the usual manner. The result in this instance was satisfactory in all respects. Watson's abdominal incision is not unlike Wölfler's.

FIG. 1156.—The operation of gastro-gastrostomy, Watson's method, showing dotted outlines of anastomoted openings.

FIG. 1157.—The operation of gastro-gastrostomy, Watson's method. *a.* Œsophagus. *c.* Cardiac end of stomach. *e.* Pylorus. *d.* Constricted portion. *f, f, f.* Ends of long sutures. *g, g.* Sutured incision through anterior wall.

The Remarks.—If pyloric obstruction is present in these cases, gastro-enterostomy is indicated, and preferably at the cardiac pouch. *Weir* regards double gastro-enterostomy as preferable to gastro-gastrostomy in these cases. In the instance of adhesions preventing the apposition characteristic of the latter method, the former should be practiced. About 17 per cent die from the operation. Watson reports 17 cases with 3 deaths.

Gastroplication.—The operation of gastroplication, also called gastrorrhaphy, consists in diminishing the size of a permanently dilated stomach by doubling in a portion of the wall and suturing together the apposing surfaces.

Bircher, after carefully emptying and washing out the stomach, made an oblique incision over the cardiac portion of the organ, six inches in length, parallel with and about an inch and a half to the right of the cartilages of the ribs. Through this incision the peritonæum was exposed and opened with strict aseptic precautions. The edges of the wound were drawn asunder,

the stomach was caught, raised well up into the wound, the anterior surface depressed by means of a long forceps, the greater curvature seized, carried
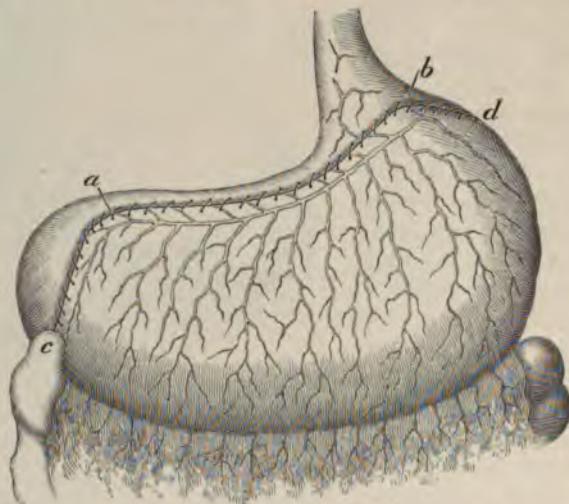
FIG. 1158.—The operation of gastroplication, Bircher's method.   *a, d.* Line of union.
b. Œsophagus.   *c.* Duodenum.

upward over the forceps, and stitched to the lesser curvature by thirty-five silk sutures (Fig. 1158) so passed as to include only the serous and muscular coats.   The stomach was returned and the abdominal wound closed at
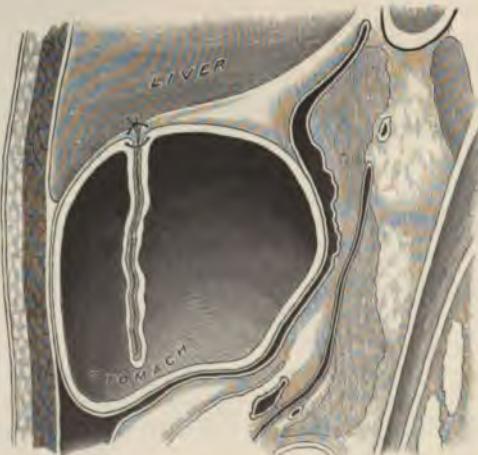
FIG. 1159.—The operation of gastroplication, Bircher's method.   Longitudinal section.

once.   The patient was nourished by the bowel for six days, was up on the twelfth, and made an uneventful recovery (Fig. 1159).

Weir, without knowledge of Bircher's achievement, practiced gastroplication on a patient on whom, twenty-seven months before, a successful ante-

rior gastro-enterostomy had been done by himself for relief of pyloric steno-sis. Weir opened the abdomen in the line of the old cicatrix for five inches, drew apart the borders of the opening, seized the stomach and pulled it up out of the wound as far as practicable, grasped the greater curvature and broke up the adhesions that prevented its proper upturning. Midway be-tween the greater and lesser curvatures pressure was made on the anterior surface, in the long axis of the organ, with a sound sufficient to cause at either side longitudinal ridges of the stomach wall, which were united together over the sound for six or eight inches with interrupted silk sutures, including the sero-muscular coats. Additional rows of sutures were applied
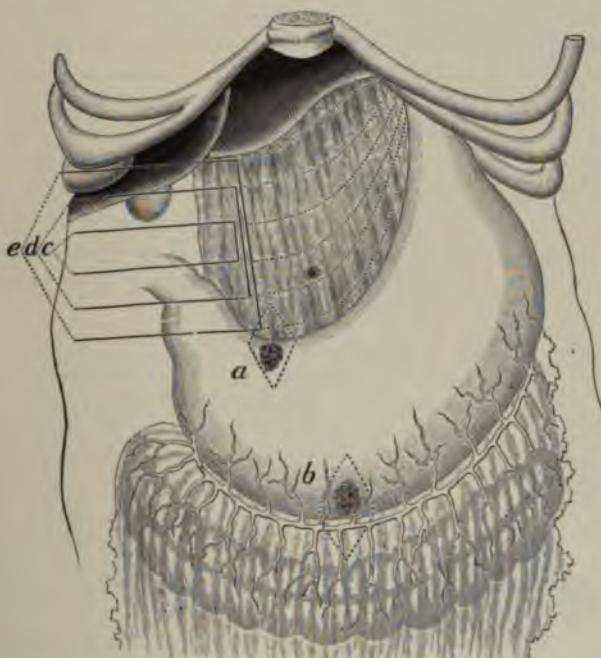
Fig. 1160.—Beyea s method of performing gastropexy. c. the first, d, the second, e, the third row of sutures. a, b. Lines of incision for removal of ulcers from lesser and greater curvatures respectively.

successively, each in a similar manner to the first, thereby forming a double fold of the stomach equal in width to that of the hand. The after-treat-ment of this patient was not dissimilar from that of Bircher's, and, like his, made a prompt recovery. Two or more plaits may be made for the purpose.

Moynihan applied to the sero-muscular coats of the anterior wall, from the cardiac to the pyloric extremities of the organ, a series of purse-string sutures, which when tied caused sufficient inrolling of the wall to reduce the stomach to suitable dimensions. The consequent bulgings at either end were so " rounded off " by means of other sutures as to per   utline of the organ. This patient had an uneventful recovery.   ured

the anterior and posterior walls, using over two hundred sutures, and, not-withstanding the length of the procedure, the patient made a satisfactory recovery.

The Remarks.—The utility of this operation is as yet uncertain, except perhaps in those cases in which relief is not afforded by pyloroplasty or gastro-enterostomy, and in these cases final outcome is not yet established. This operation should not be done in cases while suffering from obstruction at the pylorus. The use of gastroscopy, gastrodiaphany (translumination), and skiagraphy is important in recognizing structural changes of the stomach. *Einhorn's* plan of translumination is serviceable in locating the curvatures of the organ and determining the presence and extent of neoplasmatic and other kinds of thickening of the anterior surface. *Robson* reports 28 operations with 2 deaths. *The death rate* of the operation is 7 per cent.

*Beyea's Method.**—*Beyea* accomplishes the purpose by means of a plication of the gastro-hepatic and gastro-splenic ligaments in the following manner (Fig. 1160). Three rows of stitches are applied, each over the other in numerical order, as exhibited in the illustration. This kind of practice should be better than that which attaches the stomach to the abdominal wall, since the former acts by shortening the natural suspending structures of the stomach.

FIG. 1161.—Duret's method of performing gastropexy.

Bier not only shortened the suspending ligaments, but sewed the pyloric end of the stomach to the capsule of the liver, and the lesser curvature to the left lobe of the liver.

Duret passed one continuous fine silk suture from right to left through the border of the abdominal incision, including the peritonæum, then through the serous and muscular coats of the stomach near the lesser curvature, followed by two additional vertical sutures connecting points on the lesser curvature of the stomach with the parietal peritonæum opposite, left intact for that purpose (Fig. 1161), finally going out through the peritonæum, muscle, and fascia of the abdominal wall.

Davis attached the lesser omentum along a line near the lesser curvature of the stomach to the parietal peritonæum.

Rovsing passed from right to left three horizontal rows of sutures, as indicated in the illustration (Fig. 1162), through the musculo-serous structures of the anterior wall of the stomach, placing the first row just

* Phila. Med. Jour., February 7, 1903.

below the lesser curvature; the second about an inch below the first, and the third about an inch and a quarter below the second, with the ends passing through the abdominal walls at opposite sides.

The anterior surface of the stomach and the peritonæum below and near the xiphoid cartilage were scrubbed, the ends of the ligatures were united and tied, the abdominal opening was closed above, bringing the anterior surface of the stomach in firm apposition with parietal peritonæum.

The sutures remained in place for three weeks.

The Remarks.—We are disposed to regard with disfavor any·operative method that distorts the stomach at the outset or may thereafter cause
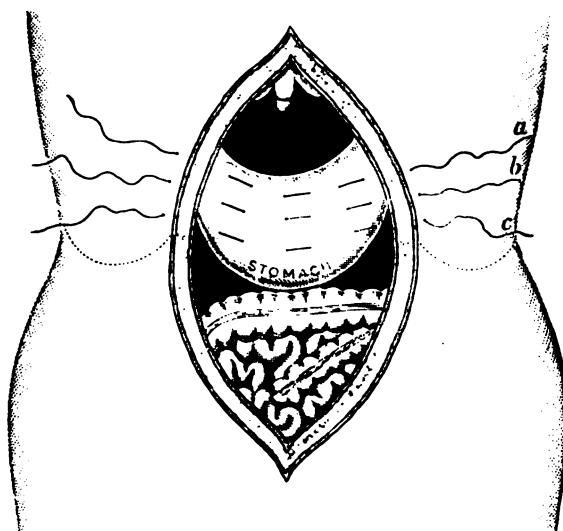

Fig. 1162.—Rovsing's method of performing gastropexy. *a, b, c.* The three sutures.

distortion by unequal or unreliable support of the organ. The operation that meets the indication by shortening the normal suspending ligaments, will, if reliable, best fulfill the requirements.

The Results.—Seventeen cases are reported; none died of the operation; nine were done by fixing the stomach to the anterior abdominal wall; the operators report improvement in the general condition of all the patients; eight were done by shortening of normal suspending ligaments; in seven, permanent relief resulted, and in one the ultimate result is unrecorded. There seems to be no doubt that much relief is afforded by these measures; sufficient at all events to prompt the effort in suitable cases; if floating kidney coexist, it should be remedied if possible at the same time.

Gastrectomy.—The term gastrectomy relates to the removal by cutting of the whole or of any part of the stomach, therefore partial and complete gastrectomy are proper expressions.

Partial Gastrectomy.—The removal of a limited portion of the stomach for the cure of ulcer, tumor, etc., comes under this heading.

Gastric Ulcer.—It is estimated that gastric ulcer occurs in from 4 to 5 per cent of the entire population (Ewald), and that the rate of mortality from perforation and hæmorrhage is 6.5, and 3 to 4 per cent respectively. A knowledge of the usual situation of gastric ulcer and of the most frequent seat of disastrous involvement is of great importance in detecting the lesion and determining the prognosis. In 793 cases analyzed by *Welch,* it appeared that the lesser curvature was invaded in 36.8 per cent, the posterior wall in 29.6, the pylorus in 12, the anterior wall in 8.7, the cardia in 6.3, the fundus in 3.7, and the greater curvature is 3.4 per cent of the cases. It is exceedingly important to note the facts, that although ulcer of the posterior surface of the stomach is three and a half times more frequent than at the anterior surface, perforation happens much oftener and is more acutely dangerous at the anterior than at the posterior aspect of the organ. *Brinton* estimates that posteriorly 2, anteriorly 85, at the cardiac end 40, at the pylorus 10, and at the lesser curvature 18 in every 100 perforate. In view of the comparative relations of the seats of perforation, *Keen* emphasizes the wisdom of a methodical search for the lesion, " beginning first with the anterior wall, next the cardia, then the lesser curvature to the pylorus, and ending the search with the posterior wall." Inasmuch as two or more ulcers are present in a fifth of all the cases, the detection of a single perforation should suggest the presence of still another where perforation is impending or complete. Acute ulcers are frequently multiple, and the chronic are rarely single. When duodenal ulcers are present, gastric ulcers are rarely absent. Duodenal ulceration is limited to the first two or three inches of the duodenum, the ulcers being side by side or opposite to each other. From six (Hauser) to sixty (Mayo) per cent of the cases of cancer of the stomach are preceded for a longer or shorter period by the history of gastric ulcer. Usually the ulcer perforates into the greater peritoneal cavity (Fig. 1078, *c*), causing early, pronounced, and extensive peritonitis. Sometimes it opens into the lesser peritoneal cavity (Fig. 1078, *b*), producing less pronounced manifestations, but often followed by abscess of the subphrenic type.

Operation for Perforated Ulcers.—The indications for treatment are self-evident and should be carried into effect without delay. Nothing whatever should be introduced into the stomach except perhaps the tube of a pump when the organ is filled, to remove the contents, which should be carefully done without flushing. Under chloroform anæsthesia (page 28, vol. i) make an incision in the median line, or vertically, invading the rectus to the left of this point, as may seem best at the time, enlarging it transversely to the left when required for better exposure and treatment of the cardia, open the peritonæum freely, separate widely the borders of the wound with retractors and expose the operation field to a strong acetylene light.

The opening of the peritonæum is sometimes attended with the escape of gas and fluids, confirmatory at once of perforation. If extravasated fluids be present they should be wiped away carefully before further manipulation is attempted, and as search is made they are removed as fast as they appear to prevent infection. If fluids are not present or are of small amount and circumscribed, the prospects are correspondingly favorable.

In either instance the contiguous tissues should be carefully protected by gauze pads or flat sponges before the stomach is handled. Examine closely and cautiously the anterior surface of the stomach, utilizing as guides to the defect escaping fluids, deepening areas of congestion, adherent lymph, and the sense of induration indicative of the base of the ulcer. The liver should be raised upward, the stomach pulled downward and forward by gentle traction on the omentum, and adhesions cautiously broken up when necessary for complete observation. The opening is securely controlled by pressure or plugging as soon as discovered, the parts are thoroughly cleansed by wiping, and the stomach is raised well up into the wound, isolated still more with gauze pads, etc., and repair is made by either of the following methods:

Inversion of the borders of the perforation and closure of the opening with one or two rows of Lembert sutures, the same as in typhoid ulcer (page 877). The Halsted suture is especially serviceable. Care should be taken to invert the entire ulcer and provide at its border tissues of sufficient strength to permit of firm and secure union. Excision of the ulcer lengthens the time of the operation without a commensurate reward in the majority of instances. Careful search should be made to detect the presence of a second perforation, and the indications of a prospective one before the stomach is returned to the abdomen. In some instances it is exceedingly difficult to locate the opening because of its small size or obscure location. An ulcer of the posterior wall, when otherwise inaccessible to examination because of adhesions, may be detected through the anterior wall by the finger. In an instance of this kind *Küster* opened the stomach, cauterized the ulcer, and then performed gastro-enterostomy with a successful issue.

When it is impossible because of thickness or rigidity of the walls of the stomach, or the presence of resistant adhesions, or the size of the opening, to apply the preceding method of cure, that of *Barker* and *Dalziel* may be utilized. After excision of the ulcer the borders of the mucous membranes and the deeper structures are brought into contact with each other independently by sutures. In the two instances in which this plan was practiced prompt recovery ensued. *Keen* suggests that greater security might be obtained by supplementing the line of union by the omental graft of Senn. In a case of this kind having a perforation three inches in diameter with indurated borders, making sewing impossible, *Bennett* plugged the opening with omentum, which he fixed in place at the borders with four or five sutures and overlapped the whole, as far as possible, with Lembert sutures. This patient made a prompt recovery.

Braun, in a case of perforation in which the borders of the opening could not be sutured together, nor to the abdominal wound because of their thin, fragile, and highly vascular state, patched the opening with omentum by interrupted sutures and performed gastro-enterostomy. This patient left the hospital in five weeks and a half " free from trouble."

Haward, in a case of collapse from perforation and in which, because of great infiltration and thickening of the stomach, he was unable to practice excision of the ulcer, sutured the margins of the ulcer to the borders of the

abdominal incision, and introduced a drainage tube into the stomach. This patient died six weeks later from purulent processes at the bases of the lungs.

Paul, in a case in which he was unable to carry into effect any form of suturing because of the dependent position of the ulcer and the existence of extensive adhesions, resorted to free drainage of the stomach by means of a tube introduced through the abdominal wound into the perforation, and so confined and surrounded with gauze as to conduct the contents of the stomach to the outside. Somewhat later a limited number of cases have received similar treatment, the majority of which recovered. It seems probable that in these latter cases either the omental plug of Bennett or the omental patch of Braun might have proved the better expedient.

After completion of the gastric portion of the procedure infinite care must be taken to thoroughly cleanse the peritonæum, otherwise the most skillful technique will fail to save the life of the patient.

The Precautions.—When perforation is suspected the patient should be caused to lie quietly on the left side, with body a little raised, and shallow breathing should be encouraged and even secured when practicable by limiting the movements of the diaphragm. Talking, coughing, and all needless efforts should be avoided. The preparations for operation should be commenced at once, so that prompt action may follow diagnosis and perhaps establish it by explorative incision. The use of the stomach tube should in no way delay preparations of operative procedure. The needs for stimulation by the most approved methods should be anticipated and provision made for prompt utilization (page 121, vol. i). Finally, it should be indelibly impressed that the additional advantages of early operation may be sacrificed by incomplete preparation and inadequate provision for suitable observation, peritoneal cleansing, and the combating of shock. Observation of the pelvic cavity should be carefully practiced, and suitably located drainage provided in dependent situations when indicated by marked infection. Narrowing of stomach orifices should be avoided.

The Results.—Those cases operated on before 1896, and within the first twelve hours, show a mortality rate of 39.18 per cent (*Weir* and *Foote*) and 28.57 per cent (*Keen*). The operations since that time give a rate of 16.66 per cent (*Keen*). In operations within twelve hours afterward (twelve to twenty-four hours) the rate of mortality is more than doubled.

Operation for Non-perforating Ulcer.—Relief from this variety of ulcer may be had by means of operations that secure rest for the disease, and by excision of the disease and closure of the wound by sewing. The attainment of the former aim is reached by pyloroplasty and by gastro-enterostomy. *Keen* favors the latter because of the " speedy emptying of the contents of the stomach " and the consequent securing of rest. Pyloroplasty is practiced by Morison and Mikulicz, each of whom scrubbed the ulcer with gauze and then repaired the defect by uniting over it with catgut the borders of the mucous membrane.

The removal by excision (partial gastrectomy) of a non-perforating and of a perforated ulcer, although an operation ideal in the conception and complete in the execution, is open to the objection that it may prolong the

operation without affording an adequate return for the time consumed. Especially is this true in instances of large ulcers: those surrounded by pronounced and extensive induration, those obscurely located, and those attended with shock from perforation or great depression from other causes. However, a sufficient number of successful cases of resection for non-perforating ulcer, especially, are recorded to commend its employment in selected cases. Rodman reports 10 operations with 2 deaths.

Rodman * urgently commends the practice of pylorectomy for the cure of ulceration by means of removal of the " ulcer-bearing area " of that part of the organism.

Operation for Hæmorrhage from Ulcer of the Stomach.—As elsewhere stated (page 954), three to four per cent having ulcer of the stomach die from hæmorrhage. The severity of the bleeding is modified, of course, by the size of the vessel involved, being active and promptly fatal in one instance, in another sapping the patient's strength by repeated small hæmorrhages, and finally causing death from exhaustion. In this operation the stomach is exposed through a median incision, and the anterior surface carefully examined by sight and touch for the vascular and indurative changes indicative of deep ulcerative action. The history of the case may not infrequently suggest the site of the morbid process. The examination is carried on as for perforated ulcer (page 955), and with exceeding caution. External examination failing to locate the site of the ulcer, a longitudinal incision is made at the anterior surface, midway between the greater and lesser curvatures, of sufficient length to permit of the introduction of the index finger for conjoined manipulation followed by an increase sufficient to afford ready inspection of the common sites of ulcer by aid of wide separation of the borders of the wound and a strong light (Fig. 999). If hæmorrhage be progressing visibly at that time, little or no trouble will be experienced in detecting the bleeding site. If, however, bleeding has already stopped, the surgeon may be much perplexed in finding the seat of the lesion, especially when it is, as often happens, of minute size. The presence of circumscribed induration, of increased vascularity, of an adherent blood clot, and of defined structural changes point to the seat of disease. Careful wiping of the surface with a soft sponge will materially aid in the search. When discovered, the margin of the ulcer may be seized with forceps and brought through the gastric opening, remembering that if the ulcer be located near to either extremity of the stomach it will be wiser to extend the gastric incision correspondingly than to make undue and likely unsuccessful traction for the purpose of withdrawal. If resisting adhesions oppose the traction and also efforts of separation with the finger, it is better that gastro-enterostomy be done without delay. After proper exposure of the ulcer it may be excised, especially if small, readily accessible, and associated with a large vessel. The wound is then closed by sewing (*gastrorrhaphy*) and the part returned. It is evident that the ligature of the bleeding points can not fail to secure primarily the vessel involved. The closure of the ulcer by continuous suture, or, if small, by tying *en*

masse the base of its pinched-up borders, or the loosening by dissection of the borders and their union by sutures, either of which places the ulcer at rest, may be practiced, provided that the vessel involved is securely tied outside of the ulcerated area. The tying may be accomplished by passing a ligature around it from without or from within, grasping at the same time a small part of the contiguous tissues. In either instance, greater security is had by burying the ligature by means of stitches passed through the sero-muscular coats. Measures of the preceding character are often open to grievous fallacies, suggesting, therefore, the need of great discretion in their use. The high rate of mortality attendant upon direct operative practice for the cure of hæmorrhage in ulcer of the stomach emphasizes the wisdom of the prompt performance of the simpler and heretofore more successful measures, pyloroplasty and gastro-enterostomy, not only after hæmorrhage, but also before, and in anticipation of the event, when medication affords no practical relief.

The Remarks.—Rapid work with a good light, continual warmth, and circulatory stimulation should be practiced. If depression be great, the free incision into the stomach for exploratory purposes should be hastened. Large sponges are best with which to empty stomach. *Cheyne* presses the posterior wall of stomach into view by one or more fingers passed through
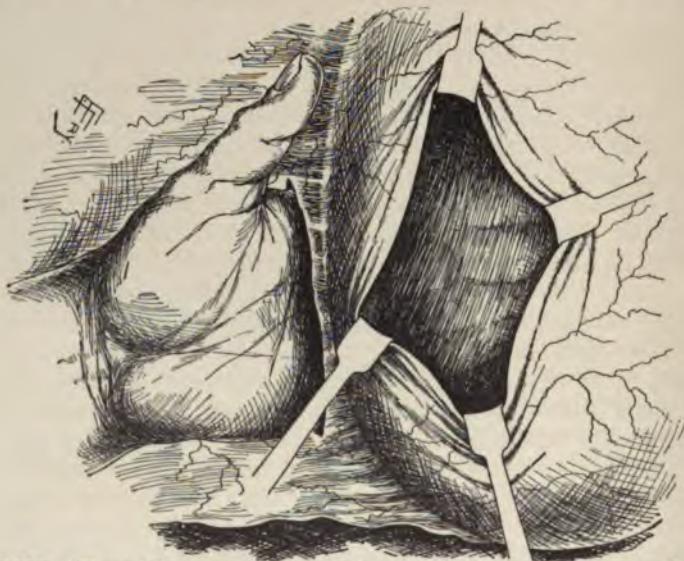
Fig. 1163.—The raising upward of posterior surface of stomach for examination.

an opening in the gastro-colic omentum made for the purpose (Fig. 1163). Examine carefully the pylorus for bleeding points. In ulcer at the greater or lesser curvature, the corresponding omentum should be removed the same as in resection of intestine (Fig. 1160, *a* and *b*). In instances of hæmorrhage from large vessels, especially of the posterior surface of the stomach with adhesions to the pancreas, either tying the bleeding points, closing of the ulcer by suture, or control at the side by suture inclusion of the vessels

in the healthy parts, followed by gastro-enterostomy, should be promptly practiced, preferably utilizing the opening already at the anterior surface of the stomach for the purpose, if time may thus be saved. The separation of the adherent parts in such cases is more liable to provoke increased bleeding than to afford special benefit. In gastrorrhagia the stomach should not be washed out before operation from fear of provoking another attack. On exposure of the stomach the pressing carefully of its contents into the duodenum may save much time and obviate infection. Cauterization of the ulcerating surface may be successful, especially if the bleeding point be small. The use of this agent is commendable when ulcers can not be excised. In the tying of small ulcers *en masse* (Fig. 1164), deep external
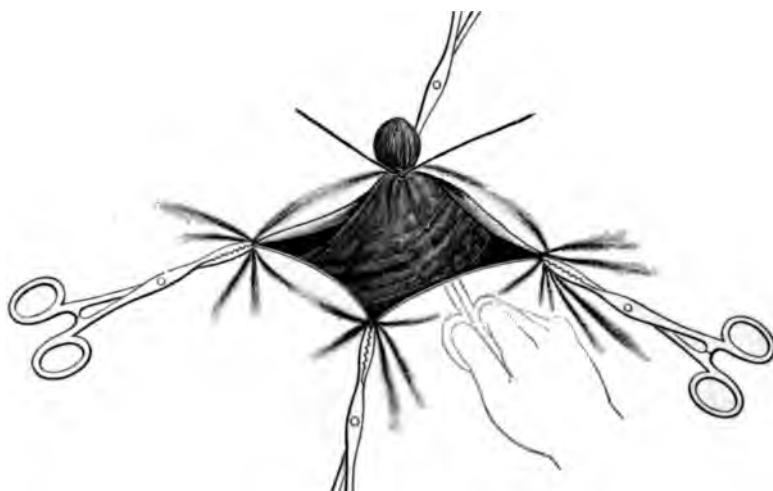
Fig. 1164.—Tying small ulcer *en masse*.

supporting sutures should be introduced along the wrinkled borders to prevent unfolding and perforation. In extensive ulceration of the pylorus without adhesions, it is often wiser to practice pylorectomy at once than to perform gastro-enterostomy. In the instances of dangerous vicarious gastric hæmorrhage gastro-enterostomy often affords prompt relief.

The Results.—In 13 operations for hæmorrhage, 9 deaths ensued. The *results of partial gastrectomy for tumors* are much better; about 85 per cent surviving.

Complete Gastrectomy.—Complete removal of the entire stomach was first accomplished successfully, September 6, 1897, by Carl Schlatter, of Zurich. Before this time eminent surgeons had successfully removed almost the entire organ on several occasions. Connor, of Cincinnati, effected the complete removal so long ago as 1883. But the credit of the attempt was hushed by the prompt death of the patient. Since the announcement of Schlatter's * case, Brigham † and McDonald, of San Francisco, and Rich-

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* Medical Record, December 25, 1897.
† Boston Medical and Surgical Journal, May 5, 1898.

ardson,* of Boston, have each reported a similar result of their own. Harvie, of Troy, and Delatour, of Brooklyn, have each operated successfully.

Schlatter's patient was a female fifty-six years of age, with complete cancerous involvement of the stomach and softened lymph nodes at the pyloric end.

The Operation.—Under morphin-ether anæsthesia and with strict asepsis an incision was made in the median line from the ensiform cartilage to the umbilicus. The tumor was found to be freely movable, and could be readily raised out of the abdominal cavity. The left lobe of the liver was then raised, the stomach completely isolated with sterilized compresses, and the omental attachments at the greater and lesser curvatures were divided in separate isolated segments with the end of Péan's forceps, and tied with silk ligatures. The stomach was dragged downward to expose the lower end of the œsophagus, which was then secured high up by Wölfler's clamp. Stillé's forceps was applied close to the cardiac aspect of the tumor, the stomach severed at the œsophageal attachment, and the end of the œsophagus protected with iodoform gauze. The duodenum was then mobilized to as near the head of the pancreas as possible, and two compression forceps were applied to it close together, the inner at the duodenal aspect of the tumor, between which the bowel was severed. The severed mass was then removed, the end of the duodenum protected with iodoform gauze, and the infected nodes were dissected away. Since only with great difficulty could the open end of the duodenum be made to touch the lower end of the œsophagus, it was manifestly impossible to unite them by direct suture. Therefore, the duodenal end was invaginated, and a suitable loop of the jejunum was carried up in front of the colon to the lower end of the œsophagus, to which it was connected by serous sutures. A longitudinal slit an inch in length was made into the bowel, and the borders of the mucous membrane of the respective openings were firmly pinned together by a continuous circular silk suture; over this a second was carried, including the sero-muscular coats, followed by a third row of the Lembert variety. The œsophageal clamp, which had been in place over two hours, was then removed, also the one on the duodenum. The abdominal wound was united in the usual manner by silk sutures, and the patient put to bed. The operation lasted nearly two hours and a half, and less than eight ounces of ether were administered. The loss of blood was slight, and the pulse at the end of the operation was 96 per minute, steady, and of fair volume. The patient made a successful recovery. The after-treatment of the case is so important and extended that the reader is invited to consult the original report.

Brigham's Case.—The patient, a female sixty-six years of age, with cancerous involvement of more than half of the stomach.

The Operation.—Under chloroform-ether anæsthesia and strict asepsis a primary incision three inches in length was made in the median line between the ensiform cartilage and the umbilicus. The parietal peritonæum and the omentum were adhered together the entire length of the incision. The stomach only was involved. It was freely movable and a large mass was noted at the pyloric extremity. Because of unusual thickness of

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* Boston Medical and Surgical Journal, October 20, 1898.

the abdominal wall the incision was extended from the ensiform cartilage to an inch below the umbilicus. Complete isolation of the stomach with hot gauze, frequently changed throughout the operation, was carried into effect. Commencing at the greater, both curvatures were freed from omenta by ligaturing with catgut in half-inch sections for three or four inches alternately, thus permitting rotation of the stomach and aiding the separation. The division at the lesser curvature was very difficult because of the greater depth of the omentum at that situation. After freeing the curvatures the duodenum was closed by clamping at two situations. One clamp was applied close to the growth, the other half an inch outside of the first, and between them the bowel was severed. The distal end of the duodenum was cleansed with a saline solution and wrapped in iodoform gauze. The gastro-splenic omentum was then tied and divided, the stomach drawn down, and two clamps were applied—one just above the cardiac orifice, the other to the œsophagus a little more than an inch above the preceding. Between them the œsophagus was divided, and the end treated with saline solution and wrapped in iodoform gauze and the stomach removed. The extremities of the duodenum and the œsophagus could be easily approximated for sewing, but as the patient's condition demanded haste a No. 3 Murphy button was used instead. The abdominal wound was closed and the patient put to bed. The time of operation was two hours and a quarter, the patient losing about two ounces of blood. Chloroform was employed at the beginning of the operation, and substituted by ether, of which about eleven ounces were administered. This patient made a good recovery.

The General Remarks.—The abbreviated details of the technique of two successful cases of complete gastrectomy are given, but with the admonition that subsequent efforts in the operation should not be attempted without careful study of the reports of the successful and unsuccessful cases in all of their bearings, remembering that not the least in importance is the after-treatment.

The Results.—Thirteen operations are reported, two of which died on the table. One patient died within thirty-six hours, another lived ten days. Two died at eleven months each, and one was living at eleven months. One alive at the end of seventeen months, one at eighteen months, and one at two years. Three not stated, but seem to have withstood the operation.

These results are surely encouraging, and will, no doubt, be greatly improved by experience and by earlier action. Excision now assumes the phase of an urgent demand in the list of important surgical expedients for cure in gastro-intestinal malignant disease.

Wounds of the Stomach.—Wounds of the stomach can be classified as are wounds of the soft parts elsewhere. The position and size of the wound and its outline, coupled with the amount, nature, and degree of fluidity of the contents of the stomach, exercise a marked influence on the gravity of the injury. Also the liability to serious complications of contiguous vessels and viscera should be recognized, especially in those wounds arising from external violence. Whether or not the injury be limited only to the anterior surface of the organ or involve as well the posterior, ought not to escape the mind of the surgeon. For in the latter instance one should

act upon the idea that infection of the lesser peritoneal cavity has already taken place, especially if the wound be of much size and the patient have been long in the dorsal posture, or much disturbed. Under these circumstances, especially in instances of gunshot wounds of the stomach, and when there is reason to believe that the organ contains any of its characteristic contents, infection of the lesser peritoneal cavity can quite safely be assumed. After exposure of the stomach in such cases, the organ should be handled so as not to encourage escape of the contents at either orifice. Therefore, it is better at once (after controlling the anterior opening) to divide the gastro-colic omentum between ligatures sufficiently to permit of the introduction of one or two fingers to the posterior surface of the stomach with the view of reaching for an opening there, than to introduce the fingers into the stomach through the anterior opening with the same object in view. By the former method discharge from the stomach through the posterior opening will not be encouraged; in fact, when the opening is found it possibly may be plugged with a finger, and thus any further escape will be prevented, while pads or sponges are being introduced beneath the stomach for protective purposes, through an increased incision of the gastro-colic omentum. In the latter instance the locating of the opening by searching anteriorly with the finger makes it necessary to force the escape into the lesser peritoneal cavity of at least a small portion of the stomach contents, to say nothing of the amount that may escape attending the stirring movements of the finger along the posterior wall before the opening is finally located. Infection in the lesser peritoneal cavity is quite difficult of removal because of the deep situation and the comparatively limited means of approach. However, extended division of the gastro-colic omentum, followed by the upturning of the stomach (Figs. 1134 and 1163), affords quite ample chance for the needed toilette. Should doubt exist regarding the removal of infecting agents, drainage should be made, opening posteriorly and laterally at one or both sides, as may seem needful. The introduction of the saline solution into the space, followed by sewing together of the divided borders of the gastro-colic omentum, except at a point ample to permit of the introduction of a glass tube communicating through the abdominal wound with the external wound, especially in markedly infective cases, are measures of great practical significance. In such methods, however, scrupulous care is required to exclude the entrance of infection from without. Nor should the surgeon in doubtful cases of injury on mere assumption delay action so long that the outcome of operative effort will assume the phase of last resort. It is much better, indeed, to reasonably assume the presence of injury, promptly explore, ascertain, and perhaps repair a threatening defect without especial danger, thus securing both comfort and safety, than to hesitate too long at the expense of both. The technique of repair of these injuries differs in no essential regard from that of similar injuries of the intestine. The closure of these wounds by sewing (*gastrorrhaphy*) is accomplished the same as that of the intestines (*enterorrhaphy*). The principles of the use of the gauze pad, isolation of the injured part, and of aseptic agents are identical. The care in the removal from the peritoneal cavity of infecting agents, securing

cleanliness, and the establishment of drainage are comparatively similar. In injury of the stomach the possibility of infection of the lesser peritoneal cavity, especially from wounds at the posterior surface of the organ, together with the need of cautious search for contiguous complications, should be kept clearly in view. Gunshot, incised, and ruptured wounds, especially of a plethoric stomach, demand prompt operative practice, even at the risk of deepening the shock. The employment of cocain anæsthesia will not be amiss, especially in those cases of shock and of extended injury contraindicating the administration of general anæsthetics, because of the depression and the physical excitement and dangers incurred from their use.

OPERATIONS ON THE LIVER, GALL BLADDER, AND BILIARY DUCTS.

The newly devised and somewhat extensive operative procedures relating to these parts of the human anatomy, together with the abnormal deviations incident to disease, require that the salient points of their relative anatomy be given at least a brief consideration. The liver alone is subject to abscess, hydatids, and various other morbid growths. It is liable to traumatism of greater or less extent and severity. The complications incident to the disease and injuries of the organ are often of greater moment than are the injuries themselves.

OPERATIONS ON THE LIVER.

The Anatomical Points.—The lower border of the fourth rib corresponds to the upper limit of the liver on the right side at the mammary line; the junction of the sixth rib with the cartilage lies close to the upper and outer limits at the left side and in front. The lung covers the liver behind down to the tenth dorsal spine, or to about the tenth rib; posteriorly the liver lies behind the lower ribs, extending from the eleventh upward to the fifth or sixth; anteriorly, at the right, it lies behind part of the ensiform cartilage and the costal cartilages of the fifth, sixth, seventh, eighth, and ninth ribs; in front, at the left, it corresponds below to the tip of the eighth costal cartilage of that side; below the ensiform cartilage it lies superficially and in contact with the abdominal wall, extending downward almost halfway to the navel. For completer details in these matters the reader is referred to the standard works on anatomy. The downward movement of the liver and the upward and outward movements of the ribs during inspiration suggest the advisability of confinement of the ribs at the right side during operative procedures on the liver if the patient's safety will permit. The thinness of the liver capsule and the friability of the liver tissue render closure of wounds of the organ a difficult and unsatisfactory procedure.

The liver can be reached for operative purposes through either the abdominal or the thoracic cavities. The former is the oftener practiced, and is known as the *Transperitoneal route*. The latter is denominated the *Thoracic route*, and may be either transpleural or subpleural in the technique. The most usual methods of transperitoneal practice are: 1, Through an oblique incision made parallel with and about one inch below

the costal border, the center corresponding to the chief points of approach, 2, through a vertical incision of the right linea semilunaris, or, if admissible, the right border of the rectus abdominis muscle. Either the oblique or vertical incisions can be extended to conform with the demands of individual cases, and for similar reasons either can be supplemented by secondary incisions made substantially at a right angle with the primary one; 3, through a curved incision made below the twelfth rib.

In either instance the course adopted is the one best intended to expose for treatment the seat of the diseased process. In each instance the steps of the technique are comparatively similar in like conditions. It may happen that satisfactory exposure requires temporary division and turning upward of the costal border (Fig. 1192) for three or four inches, thus better exposing the liver, and especially the gall bladder and its ducts. After completion of the operation the parts are restored and sutured in place when desired.

The oblique incision spares better the abdominal nerves traversing this part of the abdominal wall. However, the oblique division of the muscles at this situation causes a wound with ragged outlines, because of the severance of muscular fibers running in different directions. This fact requires that great care be taken in uniting the borders, so that no dead spaces may remain. *The vertical incision* is best for exposure of the gall bladder and the ducts, affording also a good opportunity to examine the liver. In this instance the abdominal nerves suffer more than in the former. However, the danger of terminal sequels of an incision here is much less than in the lower portion of the abdominal wall, because of the comparative differences in the abdominal contents and tension of the walls at these situations. In oblique incisions one can with care avoid division of the abdominal nerves, pulling them aside and continuing the operation. In vertical incisions this caution is available, but less convenient because of the inability to draw the nerves aside sufficiently to admit of proper technique in other respects, except, perhaps, in instances of short vertical incisions. In the making of abdominal incisions careful study of the courses of these nerves in advance of operation may enable one to locate the incision so as to avoid them entirely.

Operations for Abscess of Liver.—The operations for the relief of this affection are of a simple and a radical nature, the former being tentative only in many instances.

Aspiration.—Aspiration in hepatic abscess is of chief importance as a diagnostic measure. As a tentative act it removes often to a remoter period the danger of disastrous rupture, thus affording time to prepare the better for the use of severer measures. As a curative means little need be expected of it, not enough, in fact, to justify delay for this reason alone.

The Precautions.—Thorough asepsis of the needle by boiling and of the skin by scrubbing, etc., must be practiced to prevent infection of the liver directly by agents connected with the skin or lying within the needle. The needle should be so entered and directed as to avoid the pleura, lung, and deep vessels of the liver and abdomen. The movements of the right side of the chest should be made as quiescent as possible by mechanical means and

Paquelin's Cautery.

Fig. 1165.—Instruments employed in operations on the liver.

a. Scalpels. *b.* Bistouries. *c.* Forcipressure. *d.* Curved and straight scissors. *e.* Dissecting and mouse-tooth forceps. *f.* Needle forceps. *h.* Retractors. *i.* Sponge-holder. *j.* Drainage tube. *k.* Traction loops. *l.* Chromicized catgut. *n.* Straight and curved needles. *o.* Silkworm, silk, and catgut sutures. *p.* Large and small gauze pads with tails. *q.* Hypodermic syringe. Sponges, wipers, tenacula, costotome, and good light are also essential.

voluntary efforts during the introduction of the needle, which should be done at expiration. At all events, the outer part of the needle should be permitted to move upward and downward with the respiratory acts, to avoid injury to the liver by the inner part. A small needle can be introduced into the liver in various directions at a single sitting in search of pus, without any special danger, if care be exercised. It is wise to remember that, although pus be present in these cases, the viscidity may prevent its escape through the needle, and thus mislead instead of reassure the surgeon. However, the examination with a microscope of the contents of the needle may throw some light on the exact nature of the field traversed by it. After removal of the needle, the site of the puncture is sealed with collodion or otherwise secured in an aseptic manner.

Too great caution can not be enjoined in the employment of aspiration and of the trocar and cannula for diagnostic purposes in hepatic tumors. If adhesion of the site of exploration to the abdominal wall has already taken place either of these measures can be safely employed. In the absence of adhesions the dangers of leakage of infecting fluids into the peritoneal cavity should not be thoughtlessly encouraged. Also the danger of puncture of important normally placed or misplaced vessels ought not to escape attention. The diameter instruments employed should be as small as practicable, and be connected with strong suction and fortified with the presence of a wire stylet for removal from the lumen of the needle of obstructing influences. Evidences thereafter of resulting peritoneal infection from leakage calls for prompt operative action. The curative treatment of hepatic abscess by trocar and cannula is so uncertain and dangerous as not to deserve rank with the more radical measures.

A trocar and cannula of small diameter can be employed with the same precautions as for the needle; the cannula being allowed, if need be, to remain behind for two or three days until serous adhesions have taken place, when a drainage tube can be substituted for it. Since the trocar is larger than the needle, the danger of injury of parts and extravasation of fluids into the peritoneal cavity is increased correspondingly. The trocar is less objectionable in those cases where adhesion of serous surface has already taken place. On the whole, the use of the trocar and cannula is now regarded with disfavor except in special instances.

The Operation by Direct Incision (Abdominal Route).—After the location, by palpation or the use of the needle, of the most direct site of approach to the abscess, the evacuation can be attained by an operation consisting either of one or of two steps, as the case may require. *If by one step*, make an incision of sufficient length down upon the abscess to reach the pus if it be above the peritonæum, and to the peritonæum if below. *If the peritonæum be adherent* to the underlying wall of the abscess, introduce through it into the abscess an exploring needle of large size, followed by a narrow bistoury, and finally by the finger, thus causing the pus to escape. *If the peritonæum be not adherent*, extend the primary incision to four or five inches in length; arrest hæmorrhage and divide the peritonæum to the full extent of the wound; draw the borders of the wound apart with traction loops and shut off the peritoneal cavity from the proposed site of incision of

the liver by an abundance of aseptic gauze; introduce into the liver the aspirating needle, followed by the bistoury and finger as in the last instance. Before the pus escapes by the side of the finger, the borders of the wound are pressed against the liver to shorten the route and facilitate a safer exit. Finally, draw the liver upward with the finger inserted into the abscess cavity; increase the size of the opening with the bistoury; catch the incised borders of the liver with forceps, and evert and hold them carefully in place; sponge out the abscess cautiously, and examine the walls with the finger for other collections of pus. Arrest hæmorrhage by forceps and ligature, or by occlusion of the bleeding points with sutures carried through the border, plugging with sponges or gauze. When bleeding is arrested cleanse the parts; remove the original packing, and cleanse the peritonæum; stitch the borders of the liver opening to those of the abdominal wound, introduce drainage, and dress antiseptically.

The second step (Volkmann) is practiced in the absence of peritoneal adhesions and with the view of causing them before opening the abscess. If the condition of the patient will warrant delay after the peritonæum is exposed, it is divided and sewed to the capsule of the liver, and the wound is packed with gauze. The adhesive process can be further stimulated by numerous needle punctures in the membrane before the packing is introduced, but, for the purpose of securing adhesion of the serous surfaces, it is particularly necessary that they should be pressed together by the gauze packing. The abscess cavity should be carefully cleansed by wiping, antiseptic douching, etc., and a very large drainage tube of the proper length introduced before the wound is finally dressed. *Fontan* advises that the wall be curetted carefully, and cites instances of his own (forty) to prove that this measure is not only devoid of danger but contributes largely to the prompt recovery of the patient. Nevertheless great care should be taken.

The Operation by Direct Incision (The Thoracic Route).—By this route the subpleural and transpleural operations are practiced, the former being usually the securer of the two. The plan of procedure is attained by making an incision between the tenth and eleventh ribs in the mid-axillary line, and it is especially fitted for cases in which the liver has become adherent to the diaphragm, requiring therefore but comparatively limited space for operative purposes. If instead the liver be found not adherent to the diaphragm, limited portions of one or two ribs should be excised to secure ampler opportunity for treatment. This method of practice can not be regarded as equal to the following method, which is characterized by *the partial excision of one or more ribs at the outset.*

The Operation (Subpleural).—Resect a portion of the eleventh rib as in thoracotomy (page 1260 *et seq.*); divide in the center of the long axis the underlying periosteum. which, when drawn aside, exposes the diaphragm; incise the diaphragm in the direction of the muscular fibers, drawing them apart and exposing the liver; suture the borders of the diaphragmatic wound to the liver if they be not already adherent, and incise the liver at once, in either instance, whether adherent or not, if haste be needed; if haste be not required, pack the wound for two or three days with gauze after suturing the liver to the diaphragm, and then incise the former. *A*

subpleural operation may be effected on a higher plane (opposite the lower limit of the pleura). Resect in the usual manner corresponding portions of the eighth and ninth ribs; carefully incise in the long axis the underlying periosteum, cautiously avoiding injury of the costal pleura; detach carefully the costal pleura by blunt dissection from the ribs and the upper surface of the diaphragm and push it upward and inward and hold it in place by means of gauze packing; incise the diaphragm in the line of the muscular fibers over the site of the tumor, and draw apart the borders of the incision; sew the separated muscular borders to the liver if adhesion have not already taken place, and in either instance aspirate and incise the abscess if haste be required; or sew and pack for two or three days if adhesions be not present and no haste be needed.

The Comments.—If the walls of the opening be well lined with gauze before incising the abscess, the extent of any infection there found will likely be limited; withdraw from the abscess cavity by aspiration a sufficient amount of pus to relax the wall, thus obviating flooding of the wound when the abscess is opened. If the borders of the diaphragmatic wound be united to those of the thoracic, the area of infection will be correspondingly lessened and improved drainage secured. If the pleural cavity be invaded, collapse of the lung will occur. Prompt union of the divided borders by suture should follow wounds of this membrane.

The Operation by Transpleural Method.—Excise parts of the eighth and ninth ribs at the antero-lateral surface of the thorax; expose the costal pleura, as in the preceding plan, and unite it to the diaphragmatic layer by continuous suture; divide the two pleuræ within the circle of the sewing, thus exposing the diaphragm; suture the divided margins of the pleuræ in the form of an ellipse to the diaphragm; isolate with gauze the walls of the opening and incise the diaphragm, uniting the separated borders of the incision to the liver if adhesions to it have not already taken place; aspirate in either case and open the abscess at once if required; if not, aspirate and pack with gauze, opening later as in the preceding instance.

The Comments.—Careless sewing will cause tears in the pleura, and collapse of the lung is quite certain to follow. If time will permit, it is better to pack the wound to secure adhesion than to sew the membranes together.

It is very important, in instances of pleural involvement in these cases, to unite the pleural surfaces with each other by sewing, if not already adherent, before opening the abscess, otherwise extensive and fatal pleurisy may be provoked by entrance to the pleural cavity of some part of the escaping fluid.

Before opening the abscess greater security is insured by uniting the borders yet more closely with a continuous catgut suture. Smearing the surfaces of the wound with iodoformized vaseline can do no harm, and it may do much to prevent infection.

The Precautions.—Strict asepsis and rigid enforcement of peritoneal protection are essential to a happy outcome in these cases. Exploratory aspiration may be followed by fatal leakage, if too large a needle be used.

Perforation of a large vessel has arisen in this connection. Rough examination of an abscess cavity has given rise to fatal bleeding from rupture of a large vessel, hence caution is essential in this measure.   In some instances serous adhesion may not have taken place, even in the presence of evident pointing of the tumor.

The General Comments.—A free opening of the abscess should be made when the local evidences indicate the probability of a more or less prompt evacuation through rupture of its wall externally.   Yet it is not proper to wait for these manifestations, since rupture at a less favorable situation may happen without their presence at all.   When it is determined that pus exists in the liver, its prompt removal is demanded, not only to limit the further destruction of liver tissue by extension, but also to obviate the greater danger of loss of life from rupture.   Usually the local evidences of tumor are noted in the right hypochondriac or epigastric regions.   In rarer instances less marked evidences of lateral and posterior thoracic involvement are observed.   If only constitutional symptoms are present, the use of the aspirator is advised to detect the presence and indicate the location of the pus collection, the needle remaining as an unerring guide to the pus when found.   In doing this after the peritonæum is reached, care should be practiced to introduce the needle at the center of the area of adhesion, and the caliber of the final opening should, if practicable, be limited to this area to avoid peritoneal infection.   If the area do not correspond to the opening in the abdomen, the opening should be shaped to conform to proper drainage requirements.   If disconnected abscesses be present in the liver, one or more may escape notice even if careful examination of the abscess cavity be made with the finger, trocar, etc., after evacuation.   Little can be said in favor of the employment of cautery or caustics for the promotion of adhesion, or of the former for opening the abscess.   Abdominal incisions like the thoracic are made over the most prominent part of the tumor about three inches in length and in the long axis of the body.   The sewing of the tumor to the edges of the abdominal wound after evacuation of the pus, is facilitated by drawing the organ forward with the hooked finger and by passing all of the sutures before any are tied.   After completion of the first step of the operation, the introduction of two ligatures but a short distance apart into the tissues at the bottom of the wound, at the site of the proposed opening, will enable the surgeon to draw the structure forward into the wound and also will provide a satisfactory guide to making the incision after adhesions are established.   The drainage tube should be maintained at such a length that impingement of the end on the wall of the abscess will not happen as penetration of the liver may follow, especially when the dressings are firmly applied.   Curetting of the wall of the abscess, if done at all should be conducted with great caution to avoid the bleeding incident to severance of large vessels.   If hæmorrhage occurs, flushing of the cavity with hot antiseptic fluids and packing with iodoform gauze should be employed.

The Results.—In the absence of sepsis or peritonitis the patient usually makes a prompt and satisfactory recovery.   The abscess shrinks and finally heals with cleansing of the cavity, good drainage, and repeated dressings.

The general rate of mortality is about 40 per cent. Individual reports give more encouraging results: as, 48 cases with 35 recoveries (Dabney); 47 cases with 37 recoveries (Ferron); 80 per cent of recoveries are reported by Fontan, which good result he attributes to the use of the curette. Multiple abscesses—40 per cent—are usually fatal. Abscess of the right lobe resulted fatally in 50 per cent, and of the left in 43 per cent of the cases.

Hydatids of the Liver.—The liver is the seat of hydatid disease in nearly sixty per cent of the cases of hydatid infliction, and when multiple the liver is quite certain to be involved. The plans of operative cure are those directed to the destruction of the growth without, and with removal of the contents. Addressed to the former plan are: 1, Simple puncture; 2, puncture with removal of a small amount of the contents of the sac; 3, puncture with medication of the contents; 4, electrolysis; 5, incision; 6, excision. Aspiration with removal of a portion of the fluid is thought by some to be a comparatively safe and efficient operation, and often quite as serviceable as the more complicated and dangerous practice of introducing chemical solutions.

The Results.—The first and second plans of practice are commended by their outcome. A mortality of 19 per cent, 46 per cent of failures and 54 of successes, is reported (Thomas). Puncture as a means of diagnosis but not of treatment is commended. The third method gives a higher mortality rate than do the succeeding ones, and therefore is not to be employed except for special reasons. Electrolysis with simple puncture is no less dangerous than the preceding, but much inferior to them as a method of cure. Puncture exposes the patient to the dangers of peritoneal infection from leakage and death from hæmorrhage due to the piercing of a large vessel. The securing of adhesion before puncture, accomplished by incision, packing, etc., the same as in abscess, is a wise measure.

The Treatment by Incision.—Incision carried into effect either in one or two stages in the manner practiced for abscess of the liver is the best means of treatment. Ordinarily the cyst can be approached through an abdominal incision; sometimes, however, the posterior thoracic is demanded, depending on the point at which the cyst manifests its presence.

The treatment by excision of the cyst wall and by resection of a portion of liver infested with these cysts has been done successfully, but not yet with sufficient frequency to fix the comparative value of these methods. Excision, while ideal in its technique, exposes the patient to dangers which are not of special account in the treatment by incision.

The General Remarks.—*Hepatotomy* for the cure of hydatids differs in no essential part of its technique from that directed to the cure of abscess of the liver. The seat, size, depth, and direction of the incision, the provisions against peritoneal infection, the establishment of drainage, and the adjustment of the wound borders, are like the similar considerations in the treatment of abscess. Briefly stated, after a single diagnostic aspiration, *make an incision* down upon the tumor, sew the borders of the peritonæum to the tumor, remove the fluid portion of the contents with the aspirator, make an incision into the cyst an inch in length, and sew the borders of the opening to the non-cutaneous portion of the borders of the abdominal

wound; empty the cyst with the fingers and a spoon, examine the inner wall for additional growths and for abscess, cleanse the parts, drain, and dress antiseptically.

The tension of the cyst wall causes prompt and forcible expulsion of the contents as soon as it is punctured. The toughness of the wall often permits the pulling of the cyst outward, between the ribs or elsewhere, for safe drainage, and even its entire removal from the liver. *Thornton* advocates primary closure of the wound.

The Results.—The general rate of mortality by the direct methods varies from fourteen to forty-eight per cent; the former rate belonging to the two-stage operation directed to the primary attainment of adhesions (Volkmann). In abdominal approach the mortality rate is 10.29 per cent; in the thoracic—one stage—29.4 per cent (Thomas).

Hepatectomy is practiced for the removal of solid tumors of the liver of various kinds. The form, location, size, number, and nature of the growths exercise a great influence on the attempts and the results of operation. Pedunculated neoplasms, those of small size, single, and of benign character, can be removed successfully when accessible and superficially located. In those of sessile form and those more or less completely hidden beneath the liver surface, free incision close to the growth and enucleation are employed. An isolated malignant growth, and even two or many such growths when small and closely associated, may be removed singly by wide free dissection and by resection of the portion bearing them, especially when located at the margins of the right, or in the left lobe of the organ. The difficult part of hepatectomy relates primarily to the control of hæmorrhage and the prevention of air embolism; secondarily to the prevention of sepsis and peritoneal complications.

Pedunculated tumors and such others as may be grasped at their bases by an elastic ligature, and even a portion of the liver itself that can be similarly treated, are attacked in one or two stages and removed.

The Operation in One Stage.—After thorough asepsis and under general anæsthesia, make an incision in the abdominal wall over the tumor from the costal margin vertically, five or six inches in length; expose the parietal peritonæum, arrest hæmorrhage, open the peritonæum the entire length of the wound, bring upward into the wound the portion of liver to be removed, causing the base to be brought into close contact with the margins of the wound to which it is united by silk sutures passed through the liver substance beyond the diseased area, thence through the borders of the abdominal wound, and so tied as to firmly unite the liver with the abdomen, and causing the diseased portion to appear without; place an elastic ligature around the base of the protrusion, allow it to remain for three days, then remove and substitute another. After removal of the mass its base heals by granulation.

The Remarks.—The use of the actual cautery during the later days of treatment will hasten the separation and lessen correspondingly the putrefactive changes and the dangers of abscess and suppuration of the wound. The elastic ligature is held in place and guided by means of long, curved transfixion pins passed transversely through the base of the part to be removed.

... of the ... application of ... ligature of bleeding ... of the tamponade, and apposition of the divided ... (Fig. 10 ... vol.) or otherwise, are the compress ... to arrest bleeding. In the instances of free incision, especially ... ... prompt closure of the wound with suture limits the loss of blood and reduces the danger of air embolism to a minimum. In the case of deep parenchy... dissection, the bleeding points are tied as soon as they appear and the deep borders of the cavity are united by buried catgut suture, the superficial closed with fine sutures, the part is cleansed and returned to the abdominal cavity and the abdominal wound closed.

II ... dissection of the organ can be removed with aseptic precaution through a free abdominal incision (Figs. 1166, 1167). Control
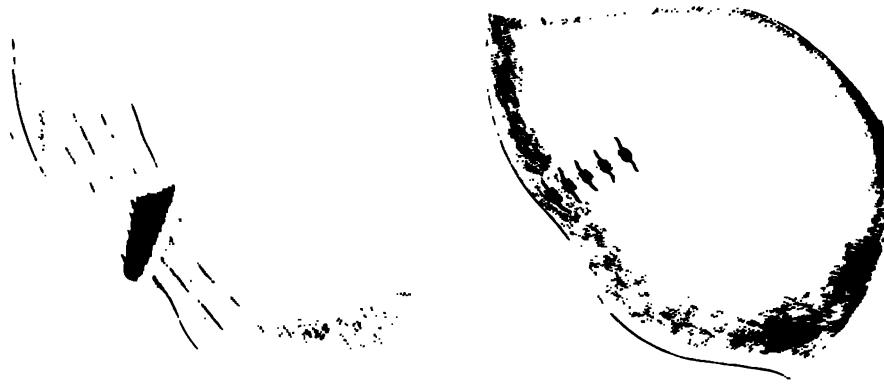
portal vein and its large branches, should be cautiously avoided. Ligature of the latter is liable to end promptly in fatal abdominal hæmorrhage. The free use of cautery for the control of bleeding is objectionable because of its
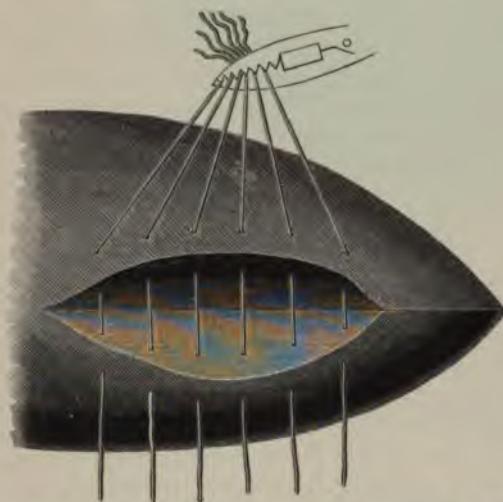
FIG. 1168.—The operation of hepatectomy. Removal of a longitudinal wedge-shaped piece.

interference with subsequent union. Caution must be exercised in suturing the liver to avoid the tearing out of the stitches; even quilled sutures and stitches carried around strips of gauze may be utilized temporarily for the purposes of better security. In the instance of failure to close a wound

FIG. 1169.—The operation of hepatectomy. Suture of wound.

of the liver completely by sewing, the remainder of the wound is properly treated by the introduction into it of iodoform gauze, which is allowed to escape externally through the abdominal wound.

The Remarks.—In those instances in which excision by cautery is made,

66

the Paquelin cautery knife is especially serviceable. Surgeons have repeatedly removed portions of the liver as well as tumors from its structure with comparative safety. The abdominal wound is not closed till danger of bleeding is over.

A large portion of liver can be removed without material injury to the patient; in fact, a third has been removed in the lower animals without a fatal result. Portions removed are speedily replaced apparently by increase in the size of already existing elements, and the functions are promptly restored. Searing the cut surface with cautery prevents the escape of bile from the open ends of the small ducts, and thereby prevents its admission to the abdominal cavity or external wound, as the case may be. Temporary digital compression of the pedicle of a growth or of the liver substance contiguous thereto will limit the flow of blood, and increased advantage in the application of pressure may be gained by passing the finger through the foramen of Winslow. The slow tightening of broad, interlocking silk sutures passed about a third of an inch apart through the liver outside of a proposed line of division will admirably control hæmorrhage. An omental patch, held in place by pressure and stitching, may soon establish an organized barrier to the escape of blood from the incised surface.

The Results.—Of 97 reported cases done by various methods, 17 (17.2 per cent) died; of these, 12½ per cent were done for gumma (Anschuetz).

Wounds of the Liver.—Wounds of the liver arise from various kinds of violence, especially blunt violence and that dependent on falls, etc. The peculiarity of the normal liver structure, and its modification by various forms of structural disease, contribute not a little to the liability of hepatic injury. The right lobe is injured about four times oftener than the left and three times more frequently than the median portion. In injuries of the liver, the characteristic freedom and persistency of the bleeding, and the presence of bile in the peritonæum, suggest the need of prompt operation. Strict asepsis should always be employed. The abdominal incision should be free and so located as to best expose the seat of the injury. The median incision only, or supplemented by another at the right or left, will commonly meet the indications. However, when located high up and well to the right, an oblique incision along the costal border, aided, perhaps, by excision of a part of one or more of the ribs, may be advisable. Collections of blood in the peritoneal cavity often indicate the seat of the injury, and their removal may furnish the evidence of continuous bleeding. *The indications for treatment* relate to the arrest of hæmorrhage, repair of the wound, cleansing of the peritonæum, and the establishment of the necessary drainage. Hæmorrhage is temporarily controlled by packing the wound with gauze or sponges, aided, perhaps, by digital or elastic pressure of the injured part of the organ. The ligature of the bleeding points with silk, and closure of the wound by deeply and closely placed silk sutures are the ideal steps of permanent arrest of bleeding and final repair of the wound (Figs. 1170, 1171). Small ruptures of the surface are closed quite well by means of purse-string sutures (Fig. 944). In the event of incomplete or non-closure of a wound for any reason, a tamponade of iodoform gauze should be introduced for a day or two, as the case may be, depending on the presence and

character of the bleeding. The use of cautery in wounds of the liver is objectionable since it interferes with the processes of repair, and invites the occurrence of secondary hæmorrhage. Tampons of sterilized gauze are

FIG. 1170.—Sewing rupture of liver with Emmet's needle.

much prompter and securer agents of arrest than cautery. In gunshot and stab wounds the hæmorrhage is arrested by tampon and such open vessels closed with silk as may be found practicable. The tampons are removed every two or three days with caution, and fresh and smaller ones introduced to facilitate drainage. The abdominal wound should not be completely closed so long as a danger of hæmorrhage or infection is present. The removal of blood clots and free blood from the peritoneal cavity should be carried into effect, and good drainage established when suggested by the possibility of the occurrence of infection.

It is worthy of note, however, that the presence of blood in the peritoneal cavity is objectionable in proportion to the degree of infection that may be associated with the injury.

FIG. 1171.—Sewing liver, sutures placed for tying.   These sutures are too small.

The Results. — In rupture prompt operative action appears to increase the rate of recovery from 15 per cent to 45, in gunshot wounds from 55 per cent to 70, and in stab wounds from 64 per cent to quite 75.

Hepatopexy.—Hepatopexy relates to the cure of abnormal mobility of part of or the entire liver by fixation of the organ to the abdominal wall.

The requisite incision for fixation is made over the prolapsed part of the liver parallel with the costal border, the liver is reduced to the normal position and retained by means of several stout silk sutures connecting it with the posterior surface of the abdominal wall. The patient is required to lie still for several weeks in order to secure as firm union as possible.

Ramsy fastened a prolapsed liver in place successfully by means of strong silk ligatures passed through the round ligament and over the cartilage of the seventh rib and tied, aided by a kangaroo tendon connecting the extreme right lobe of the liver with the abdominal wall corresponding to that point.

Jonas cured a patient by replacing the liver and sewing the gall bladder to the abdominal wall. *Depage* practiced the resection of a portion of the abdominal wall as an element of cure. In all cases of this deformity, it is wise to suspend at the same time such other organs as may exercise traction on the liver, when circumstances will permit.

The Results.—The results of 11 cases noted justify the course pursued, and encourage further efforts to remedy the ill effects in Glenard's disease. Of these, 8 recovered completely, 1 died, 1 not reported.

Hepaticostomy (Hepatostomy).—Hepastotomy consists in the establishment of a fistulous communication between one or more extra-hepatic bile ducts and the surface of the body to relieve the ducts of accumulated bile due to obstruction from biliary calculi. An abdominal incision is made over the portion of the liver harboring the distended ducts, and after careful isolation of the field of operation an incision is made into the liver and deepened until the dilated duct is reached. Careful cleansing of the wound and renewed packing of the field is done before the duct is opened, to avoid the possibility of infection from the escape of its contents. The duct is then opened, the wound carefully cleansed, and the gallstones are removed. The presence of other dilated ducts are sought for and relieved in a similar manner as the preceding. The wound is again carefully cleansed, the borders of the hepatic and gall-duct incisions are united to those of the abdominal wound by sewing, and the remaining portions of the latter wound are closed with sutures, leaving the fistulous opening to heal.

The Results.—*Thornton* operated successfully upon a patient by this method of practice.

The Operation for the Cure of Ascites from Cirrhosis of the Liver (Epiplopexy).—This operation was proposed by Talma and carried into effect by Drummond and Morison, in 1896.

Morison opened the abdomen in the median line between the umbilicus and the pubis, removed the fluid by sponging, scrubbed the anterior parietal peritonæum, also the visceral layers of the spleen and liver and the parietal portions corresponding with them. He then united with sutures successively the scrubbed surfaces of the spleen and the liver, and the anterior surface of the great omentum, with the corresponding scrubbed surfaces of the parietal peritonæum. The abdominal wound was then closed except at the lower end, through which a glass tube was passed into Douglas's pouch. The abdomen was then supported firmly by several adhesive strips passed around it, thus maintaining the apposed surfaces in suitable con-

tact for final adhesion. Various methods of procedure are now practiced, of which the following one may be regarded a fair example:

The Operation.—After thorough aseptic preparation make an incision above the navel, a little to the left of the median line, thus avoiding the vessels of the round ligament; tap and remove the fluid before incising the peritonæum; expose, inspect, and palpate the liver to confirm the diagnosis; dry and gently rub with gauze, the peritoneal surfaces of the liver and omentum, and the parietal peritonæum naturally corresponding to the aforesaid structures; sew the omentum to the abdominal wall at several places and close the incision; dress the wound and surround the abdomen with broad adhesive strips from below the navel to the ensiform cartilage, thus bringing the scrubbed peritoneal surfaces in contact with each other; maintain the patient in the dorsal posture until the united surfaces are adherent if practicable.

The operation by packing in the omentum is practiced in two general ways. The first method: Cut vertically down from the navel upon the peritonæum for five or six inches, and push aside the superimposed tissues, by means of blunt dissection with the fingers and scalpel; divide transversely for three or four inches the peritonæum at the upper angle of the wound; raise out of the abdomen, through the transverse opening, the omentum, and apply it evenly to the external surface of the exposed peritonæum, tucking it in at the sides and stitching it in place; close by sewing any excess of the opening through the peritonæum and close the abdominal wound, thus burying the transferred omentum; unite the borders and dress the part as in the preceding instance.

The Second Method (Schiassi).—Make an incision six or eight inches in length, in the line of the right nipple from the costal arch downward; make a second incision from the junction of the middle and upper thirds of the first directly inward to an inch beyond the median line; divide the intervening tissues along these lines down to the peritonæum; remove the fluid from the peritoneal cavity through a small opening made at this place; separate the flaps from the peritonæum and hold them aside with traction loops; make of the peritonæum a triangular flap similar to that of the superimposed tissues; remove the omentum from the peritoneal cavity and fit it carefully to the external surface of the triangular serous flap, sewing them together; wipe the exposed surface of the omentum lightly with gauze soaked in a weak solution of bichloride of mercury to facilitate adhesions; restore the tissues in place and unite and dress the wound as before described.

The Comments.—We do not see any advantages in this latter over the preceding method, and believe that there are many disadvantages connected with it, making the former preferable.

The General Remarks.—The fluid should be removed from the abdomen before the incision for examination of the liver is made, to prevent the escape of the floating intestines through the opening; changing the position of the patient so as to float the intestines above the opening will obviate the difficulty. Drainage above the pubis is the better if continued, as the danger of infection is removed from the seat of operation. Unless

the drainage is in the keeping of expert attention, infection is apt to result, therefore drainage should be dispensed with except when under fitting scrutiny. The usual presence of important concomitant disease in these cases removes the operation from the comparatively safe field of operative action to the somewhat grave and dangerous domain of major operative practice.

Aspirate accumulating fluid during the process of healing if the wound have been closed at the time of operation, for reasons of comfort and to prevent separation of apposed tissues.

Each case should be considered upon its individual merits, rather than one of a class to be treated in a definite manner. In long-standing cases attended with distention the omentum may become so attenuated as to be scarcely amenable to handling, or be found already adherent to the abdominal wall with highly developed vascular connection therewith, which should be carefully husbanded rather than destroyed with the futile idea of providing a better one. The writer has lately met with a case of this kind. The omentum may be found rolled up into a complicated mass, requiring careful unrolling, which is sometimes impossible. In sewing the omentum to the opposed tissue, carefully avoid any encroachment on a vessel that can contribute to the circulation of the parts. The omentum may be pocketed between any of the layers of the abdominal wall except where an opposing layer is fatty. When the spleen is enlarged it should be scrubbed and anchored.

Müller reports finding the ascites in one instance due to inflammatory adhesions choking the portal circulation, which when released effected a cure.

The Results.—*Greenough* * reports 122 cases of cirrhosis of the liver, treated surgically, 105 of which had ascites; of which 42 per cent were improved and 58 per cent not improved. Twenty-nine and a half per cent died within thirty days after operation and 9 were in improved state two years after operation. Enlarged liver gave a lower rate than atrophic liver, and suture of the omentum between layers of the abdominal wall was followed by the best results. The many instances of practical cure following tapping and the uncertainty of the exact pathological state of the liver, together with the often somewhat formidable character of the operation and the liability of infection, still invest the operation with an element of doubtful expediency.

Operations on the Gall Bladder.—The gall bladder is frequently operated on for the removal of gallstones, purulent collections, etc.

The Anatomical Points.—The normal gall bladder is from two and a half to five inches in length, an inch and a half across at the widest point, holds about an ounce, and contains calculi in about ten per cent of the adult subjects. When filled, the fundus extends beyond the border of the liver at a point corresponding to the cartilage of the ninth or tenth rib, more frequently the former. The upper surface lies in contact with and is attached to the liver by connective tissue, while the under surface and the sides are covered with peritonæum (Fig. 1175). *Brewer* reports

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* American Journal of Medical Science, December, 1902.

the presence of a distinct mesentery in four per cent of a hundred dissection made by himself, and in these instances frequently supplemented by an outward extension of the lesser omentum, thus forming a double mesenteric arrangement. The late *Greig Smith* reported somewhat similar findings. The under surface lies in close connection with the first part of the duodenum and the hepatic flexure of the colon. The cystic duct is about an inch and a half to two inches long, and lined with mucous mem-
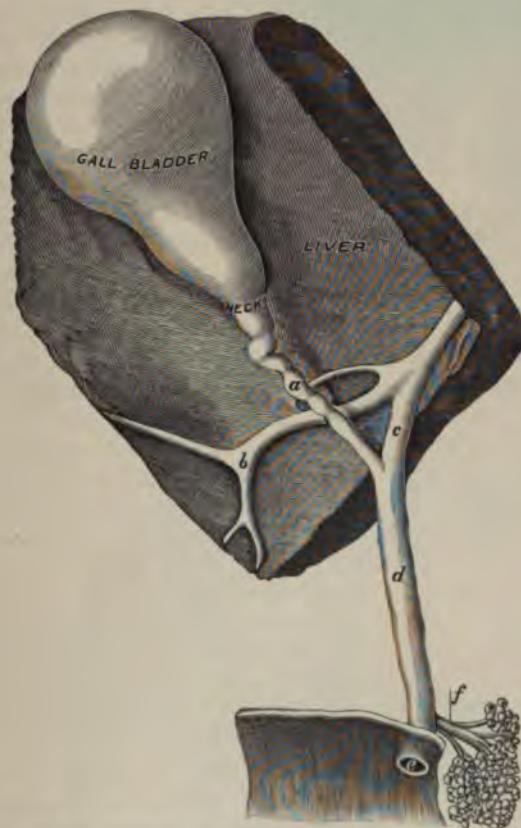
Fig. 1172.—The biliary vessels and gall bladder. *a.* Cystic duct. *b.* Bile duct. *c.* Hepatic duct. *d.* Common duct. *e.* Duodenal orifice. *f.* Duct of Wirsung.

brane so arranged in a spiral manner around the lumen as to narrow the caliber, rarely permitting the introduction of a probe, and resisting the removal of calculi (Fig. 1173). This duct runs downward to the left in the lesser omentum, having the hepatic artery on its left and the portal vein behind it, and joins the hepatic duct at an acute angle (Fig. 1174). The hepatic duct is about two inches long and arises by two branches, one each from the right and left lobes of the liver, and runs downward and to the left in the lesser omentum with the hepatic artery at the left side. The common duct varies in length from an inch and a half to about five

inches, having an average length of about three inches, is formed by the cystic and hepatic ducts, and passes at first between the layers of the lesser omentum in front of the portal vein, to the right of the hepatic artery, and behind the first part of the duodenum (Fig. 1175); it then passes between the second part of this intestine and the head of the pancreas, and ends by entering obliquely into the lower part of the second portion of the duodenum, lying in the walls of the gut for three fourths of an inch before its termination, which is marked by a small mucous papilla located about three and a half to four inches from the pylorus. *Brewer* points out the fact that the papilla (Fig. 1173) can be located quite well in the living subject by passing the left index finger through an opening made into the second portion of the gut, downward, inward, and backward to a point about an inch and a half below the crescentic fold of mucous membrane located at the flexure indicating the junction of the first two portions of the duodenum, the fold resting opposite the middle of the second phalanx, and its presence being "markedly accentuated by upward traction of the edges of the wound." The general diameter of the common duct is two lines; below its junction with the pancreatic it is three lines. The smallest diameter is at the entrance of the duodenum.

Fig. 1173.—The gall bladder and biliary ducts. *a*. Cavity of the gall bladder. *b*. Neck of the gall bladder. *c*. Cystic duct. *d*. Spiral valve of cystic duct. *e*. Common hepatic duct. *f*. Common bile duct. *g*. Pancreatic duct. *h*. Ampulla of Vater. *i*. Second portion of duodenum. *j*. Biliary papilla.

The tapping with a trocar and cannula and the aspiration of a distended gall bladder are by no means trivial matters. Not infrequently a resulting leakage has been followed by fatal peritonitis and death. Neither of these measures can be regarded as wise for the purpose of diagnosis, as they are less safe as primary measures than is an explorative incision. The latter when properly conducted is devoid of special danger, and therefore may constitute wisely the primary step of complete operative relief. The tapping or aspiration of an exposed and thoroughly isolated gall bladder for the purpose of diagnosis or relief from overdistention is prudent and justifiable practice.

The introduction through the abdominal wall into the gall bladder of a long, slender needle, either independently or combined with trocar and cannula, for the purpose of determining the presence of calculi, is dangerous, and made unjustifiable by the efficacy of explorative incision with strict asepsis and localized anæsthesia.
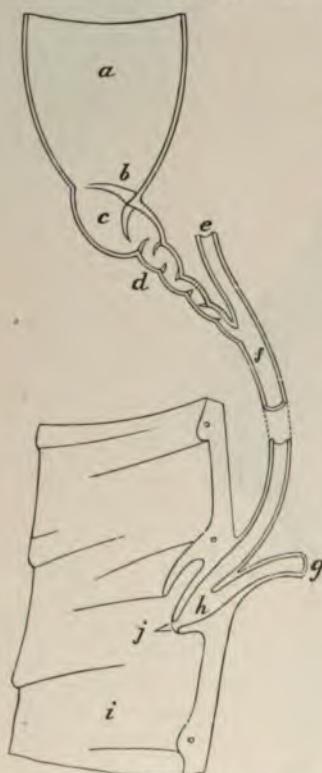
Cholecystostomy.—Cholecystostomy is a term applied to the operation of opening the gall bladder for the purpose of removal of the contents. The operation may be completed at one or two stages and, in the first instance, the contents of the tumor may be evacuated before or after sewing the walls of the tumor to the borders of the abdominal wound.

The Operation (primary incision and secondary fixation of the gall bladder to the abdominal wall).—After the necessary aseptic precautions, with the patient lying on the back, locate the cartilage of the tenth rib and make an incision from it downward and forward in the course of the fibers of the external oblique muscle for three or four inches; separate

Fig. 1174.—Relation of vessels at and below the transverse fissure. *a*. Gall bladder. *b*. Cystic duct. *c*. Common duct. *d*. Hepatic duct. *e*. Hepatic artery. *f*. Hepatic vein.

and draw apart the fibers of this muscle and those of the succeeding muscles as they appear (*Greig Smith*); pinch up and divide the peritonæum;
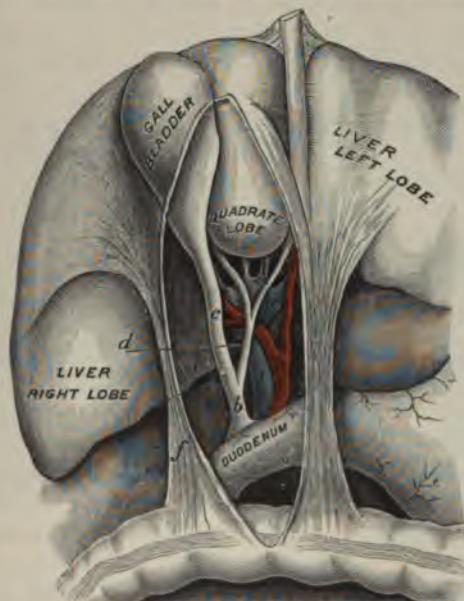
Fig. 1175.—Anatomical relations at the under surface of the liver. *a, a*. Portal vein. *b*. Common duct. *c*. Cystic duct. *d*. Hepatic duct. *e*. Hepatic artery. *f*. Hepatico-duodenal ligament—i. e., right border of the lesser omentum.

introduce the index finger to the abdominal cavity and explore the gall bladder if it be not too much distended for this purpose; if non-adherent

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pack the borders of the exposed part of the bladder with gauze or sponges, introduce a small trocar or fine aspirating needle at the lowest point of the exposed part, and as the contents escape seize the relaxing walls of the bladder above and below the point of puncture with fine forceps and draw the bladder cautiously into the abdominal wound and even through it, if the conditions will permit. When the fluid is removed, place a broad sponge around the exposed part and make a vertical incision with scissors into the bladder of sufficient size to admit the finger; grasp the sides of the incision close to the border with forceps, or control them by means of traction loops; draw the bladder still farther forward and give the forceps or loops in charge of an assistant; arrest hæmorrhage; introduce the index finger into the cavity of the bladder and note its contents; remove small stones with a scoop, larger ones with forceps, and liberate impacted ones with the finger or scoop, combined with external manipulation, being careful not to tear or bruise the walls of the gall bladder and cystic duct. Stones immovably fixed in the cystic duct require a special technique for removal (page 993 *et seq.*). Having removed the stones, thoroughly cleanse the parts, including the cavity of the gall bladder, with aseptic fluid; remove the sponges, noting that all are accounted for; push aside the intestines and begin a systematic examination of the cystic, common, and hepatic ducts to ascertain the presence of movable or impacted calculi; cleanse the peritonæum and suture the borders of the wound in the gall bladder by continuous or interrupted stitches to those of the abdominal wound, omitting the skin; pass, when feasible, all of the sutures before tying any. Introduce a rubber drainage tube up to the cystic duct that it may better convey away the bile, or close the opening in the bladder around the tube with a purse-string stitch for the same purpose; apply to the wound iodoform gauze and around the tube the ordinary aseptic variety, which is changed as circumstances require. The sutures are removed at the end of a week, the drainage tube being kept in place longer if need be. The resulting biliary fistula will soon close if the common duct be pervious; if not, a permanent fistula will follow which requires special treatment for cure (page 1003). If the gall bladder be too much shrunken to permit of its union with the borders of the wound in the manner just described, the peritonæum should be separated and turned upward and sewed to the shriveled edges of the bladder. *Robson* advises that the great omentum be raised up and utilized for the purpose. *Murphy* has modified his button for the purpose, and in writing of the matter, he says: " It can be easily and rapidly inserted deep in the abdominal cavity, though the gall bladder may be very much contracted; it also prevents with certainty the contact of the gall-bladder contents with the abdominal viscera until such time as adhesions have formed around the tube; and finally it leaves a large opening when the instrument is withdrawn from the gall bladder, through which calculi may be extracted."

The operation with the button tube is performed as follows: An incision is made in the abdominal wall, beginning at the ninth costal cartilage, parallel to the external border of the rectus muscle for a distance of two and one-half inches. The gall bladder is located, a sufficient surface of

FIG. 1176.—Instruments employed in operations on the gall bladder and gall ducts.

a. Curved and straight scissors. *b.* Needle holder. *c.* Stone forceps. *d.* Forceps for crushing, with rubber-protected jaws. *e, f, g, h.* Forceps for catching calculi. *i.* Long silver probe. *j.* Scoop. *k.* Hypodermic syringe and mouse-tooth forceps. *l.* Chromicized catgut. *m.* Halsted's hammer (assorted sizes). *n.* Sponge-holder. *o.* Costotome. *p.* Blunt hook, tenaculum, and blunt retractor. *q.* Spatula. *r.* Halsted's curved needles. *s.* Curved needles for sewing and straight for breaking calculi. Scalpels, bistouries, forcipressure, ligatures, anchored wipers, etc., are needed.

its wall exposed, the contents are aspirated, the purse-string suture is introduced, the gall bladder incised, the male half of the button inserted, and the purse string tied and cut short; the tubular portion of the button is then pressed into position, the tube drawn out as far as the gall bladder will permit, and held there with a pin passed through the openings in the side (Fig. 1177). If a double row of purse-string sutures, half an inch apart, be introduced around the gall bladder and a rubber tube inserted in the viscus and the first row tightened, the tube pressed up still further into the gall bladder and the second row tightened half an inch below the first, a secure adjustment will be effected. If the tube be then packed around about with gauze, no fear of escape of bile need be entertained.

FIG. 1177.—Murphy's modified button for drainage in cholecystotomy.

The Precautions.—Soiling of the peritonæum with the fluids, and the loss of sponges in the abdominal cavity, must be carefully prevented. Bruising of the gall bladder by manipulation or forcipressure should be avoided, since sloughing may be the result. The gall bladder should be seized in the line of its proposed division, so that pinched tissue will lead to no significant harm. The aspirating needle should be inserted as low down as possible, so that the puncture will not be obscured by retraction of the gall bladder with the escape of the fluid. The common duct should be examined carefully for irremediable obstruction before the gall bladder is sewed to the abdominal wound, and if thus obstructed cholecystenterostomy should be performed. At this time the portion of intestine corresponding to the end of the duct should receive careful manipulative investigation, as a small stone or an insignificantly small morbid growth there may impede the escape of bile. The writer has met with a case of the latter kind. The sewing of the borders of the gall bladder to the integument begets, not infrequently, biliary fistula, which may be avoided by sewing the gall bladder to the aponeurosis instead of to the integument; therefore, a biliary fistula will close much quicker if the integument be omitted in joining the abdominal wound with the gall bladder. If remediable obstruction of the common duct have escaped the attention of the surgeon at the time of operation, the fistula resulting from its presence can be cured only by removal of the obstructing cause. For this purpose a probe can be carefully used to push a stone along, or other operative means employed to remove the obstructing cause. The injection of fluids to dissolve the stone is exploited, but it can not be regarded with favor. The practice of closure of the gall bladder and its return to the abdominal cavity, with immediate closure of the abdominal wound (cholecystotomy), should be practiced with discretion. The temporary advantages gained by this course do not always, in our judgment, offset the dangers that may follow it.

The Remarks.—If the bladder be not much distended, aspiration can

be omitted and a free incision made at once, the fluid being caught by sponges or conducted away by a small trough of rubber tissue, oiled silk, etc. The direction of the abdominal incision is varied according to the predilection of the operator, the needs for observation and manipulation of the organs, and the preservation of the abdominal nerves. *Keen* advises that it be made parallel with the cartilaginous borders of the ribs; *Czerny* recommends a right-angled incision, so placed that the fundus of the bladder shall lie between the vertical and horizontal parts of the cut. The "gridiron" dissection of Greig Smith is often of ample dimension, and, like the others, can be extended to meet the requirements by division of the muscular fibers, going even into the rectus abdominis if need be. In this plan the natural tendency of the separated fibers to come together prevents undue subsequent weakening of the abdominal wall at the seat of operation. A vertical incision in the rectus or in the linea semilunaris is convenient for explorative purposes. It may be necessary to break up connecting adhesions before the bladder can be brought into the wound sufficiently to prevent peritoneal infection. If the gall bladder be adherent to the abdominal wall already (one stage), or be sewed to it before evacuation (two stages) of the tumor (primary fixation and secondary incision), there is less danger of peritoneal infection, but the operation is necessarily less complete because of the inability to examine the outlying ducts for the presence of calculi. However, in all other respects the technique is similar to the method by primary incision and secondary fixation of the gall bladder. Cholecystostomy and the removal of the cause demanding the operation implies much indeed, and sometimes more than can be attained. Therefore, the surgeon should be prepared to meet the demands of every phase of the case in an operative sense, and likewise to be reconciled to complete failure in a philosophical one. In many instances this operation is simple indeed, and quickly performed. However, in those cases where the gall bladder is small and shrunken or enveloped in distorting adhesions, or encroached upon by distended intestines and adherent omentum, associated not infrequently with circumscribed suppuration, the attainment of the object is always tedious, and is often dangerous because of premature escape of pus, or of injury to important vessels. In all such cases the field of operation should be carefully isolated with gauze pads and the adhesions cautiously separated or severed by patient blunt dissection with grooved director and scissors, until the gall bladder and the ducts are brought under examination. Sewing is often difficult and sometimes impossible because of the shrunken and weakened state of the gall bladder; hence, peritoneal flaps carried from the abdominal wall or omental tissue drawn into place, and discreet packing of gauze, are the means at command for isolation purposes. Absorptive agents, such as sponges and gauze, may be introduced, being changed occasionally when wet with discharges, thus preventing extended infection. In these cases, both the patience and ingenuity of the operator will be severely tested in the securing of a successful issue. Had the gall bladder been drained at the outset of the trouble, there can now be little doubt of the fact that the severer heritages would have been obviated.

The Results.—The death rate in the absence of cholæmia is about 3 per cent, and even less in some instances. With protracted cholæmia the rate is increased and is chiefly due to the shock and hæmorrhage provoked by the cholæmic state. *Kehr* estimates that 10 per cent of his country-men have gallstones, half of which cause trouble. *Mosher* * in 1,655 autop-sies found gallstones present in about 7 per cent of the cases. Of 1,100 cases, 82 (7.4 per cent) died. *Mayo* reports 208 uncomplicated cases of stone in the gall bladder, with two deaths; 183 cases of impacted stones in the pelvis or cystic duct, with six deaths; 58 stones in the common duct, with three deaths. *Kehr* reports 96 cases in one-stage operation and 3 in two stages; all recovered. *Robson* reports 115 cases, with five deaths, three of which were subjects of cancer and two of suppurative cholangeitis with jaundice. The foregoing are the results of the individual experience of operators whose opportunities have made them masters of the procedure. However, the outcome of miscellaneous operations are far in advance of those of but three years ago. The permanency of the case depends upon the primary cause and the appearance of secondary ones. When the disease will return, if ever, no one can safely prognosticate. However, the annoy-ance and danger of its presence can now be safely avoided if heed be given early primary manifestations.

Cholecystotomy (Cholecystendysis).—Cholecystotomy consists in clos-ing the opening in the gall bladder, returning it to the abdomen, and unit-ing the abdominal wound partially or completely at one sitting. When this course is contemplated the ducts should be unobstructed, the opening made into the gall bladder small and near to the fundus, the borders not lacer-ated, and healthy, the calculi not large, readily removed entire or in frag-ments, and without the presence of evidences of infection or peritonitis. The reverse of these conditions contraindicate the adoption of the proce-dure. The margins of the incision and of a rupture of the gall bladder should be carefully united, and preferably by three rows of sutures. The first row, a continuous suture of catgut, uniting only the borders of the mucous membrane; the second of fine interrupted silk, joining together the fibrous coats; the third row of a similar kind as the second, and uniting the serous layers after the manner of Lembert. Two rows only are fre-quently employed.

The Remarks.—The plan (Zielewicz) of temporarily closing the cystic duct with a catgut ligature, so as to permit union of the line of sewing before the absorption of the ligature allows bile to enter the bladder, is open to the objection of failure because of lax tying, or the causation of ulcera-tion and stricture on account of too firm seizure and delayed absorption of the ligature. *Czerny's* proposition of uniting the closed margins of the wound in the gall bladder to the peritonæum of the abdominal wound and entire closure of the latter in the usual manner is needlessly unsafe, as the leaving open of a small portion of the abdominal wound will obviate the danger of peritoneal infection without materially delaying cure. Whenever the borders of the opening in the gall bladder are torn or bruised, from rupture or manipulation, they should be trimmed before sewing. Calculi

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* Johns Hopkins Hospital Bulletin, August, 1901.

of large size should be broken before removal, and cautiously extracted to avoid bruising of the borders of the opening into the gall bladder.

The Results.—In 59 cases 45 recovered and 9 died, 3 directly and 6 indirectly, from the operation. Four of the remainder sustained recurrence and one continuous fistula.

Cholecystectomy.—Cholecystectomy is a term applied to the operation of removal of the gall bladder. It is especially adapted to those cases in which the gall bladder is so much shrunken, thinned, or atrophied as to prevent sewing it to the abdominal wound; also to those in which the cystic duct is closed by structural thickening. Limited cancer of the gall bladder, extensive ulceration or rupture, overdistention, with complete closure of the duct and the presence of a persistent mucous fistula, also are indications for the operation. It is proper to say, however, that the removal of the gall bladder presupposes that no gallstones are present in the biliary tract, and emphasizes the hope that none will appear thereafter, since it eliminates one avenue of lodgment and escape, and proportionately measures the gravity of their presence, also that the need for drainage at this point is not required.

The Operation.—Expose the gall bladder as for cholecystotomy; isolate the organ from the peritoneal cavity with abundant sponge or gauze packing; turn up the border of the liver; make two parallel incisions, one at either side of the gall bladder, through the restraining peritonæum (Fig. 1175); separate the gall bladder from the liver from the fundus upward to the cystic duct; divide the duct between two ligatures; asepticize the proximal end with cautery; unite the peritoneal flaps with stitches; close the abdominal wound promptly and completely when thorough asepsis is assured, or introduce a small drainage tube leading to the seat of the operation, especially to the end of the duct, if thought wise. A single incision along the gall bladder and cystic duct with reflection of the peritoneal flaps may be employed.

The Remarks.—Sometimes adhesions and hæmorrhage complicate the operation, requiring the use of forcipressure, ligatures, etc., and extension of the abdominal incision for a better view and manipulation. Cholæmia predisposes strongly to hæmorrhage, and, when trouble is anticipated, packing of the wound should be practiced for two or three days before complete closure is made. *Mayo* advises removal only of the mucous membrane, leaving behind the remaining coats of the gall bladder, which are loosely stuffed with gauze and united to the abdominal wound for drainage purposes. *Mayo* reports several cases apparently commendatory of this practice. That it is a wise measure in instances of doubtful exclusion of infection from the cystic end of the organ, were removal practiced, seems evident. But in instances of inflammation with rigid walls, adherent lining membrane, and inadequate tissue for the purpose, comment is not necessary. *Senn* has expressed doubt of the general expediency of the practice. In instances of hour-glass gall bladder the redundancy may be removed and the remaining portion treated with a drainage tube fastened in with a purse-string suture and its borders sewed to the aponeurosis of the abdominal wall; a dilated cystic duct after removal of the gall bladder may be anas-

tomosed with the intestines effectively. Of 351 cases done for all causes 49 died. *Martig* reports 87 cases, with 15 deaths. *Kehr* 101 cases, with 3 deaths. *Mayo* 70 cases, with 3 deaths. *Terrier* 16 cases, with 4 deaths. *Robson* reports 28 cases, with 4 deaths. These include malignant and simple cases. Also he reports 12 cholecystectomies for malignant disease, of which 9 recovered; 1 remaining well three and another four years after operation. The death rate in miscellaneous cases is several per cent greater than in a personal series.

Cholecystectomy with Partial Hepatectomy, etc.—Ample encouragement warrants the removal of contiguous diseased liver, stomach, or intestine, along with a gall bladder afflicted with cancer. The elastic ligature and the cautery are the chief agents selected for the purpose in connection with the liver. The technique is in all essential regards like that of each operative procedure in uncomplicated instances. Greater preparatory considerations relating to shock, hæmorrhage, and sepsis are essential in such cases as these (page 121, vol. i).

Cholecystenterostomy.—Cholecystenterostomy is the establishment of a biliary fistula between the gall bladder and the intestine, usually the duodenum, for the relief of cholæmia incident to complete division, ulcerative perforation, and irremediable obstruction of the common duct. It is advised also in chronic cholecystitis in some cases, persistent fistula from irremediable obstruction, and for cholæmia and its tormenting complications in cancer of the head of the pancreas. In a case of the latter kind operated on by the writer, the patient was quite promptly relieved of the cholæmia and its inflictions, and lived for three months in comparative comfort.

The Operation.—Open the abdomen through a vertical incision three inches in length, located at the outer border of the right rectus muscle just below the ribs; draw apart the borders of the wound with traction sutures; carefully examine the parts and raise the gall bladder and duodenum into the wound and isolate them with aseptic pads; clear the intestine selected of its contents for a space of three or four inches by digital manipulation and clamp the outer limits of the space; insert a needle armed with a silk ligature fifteen inches in length into and through the wall of the duodenum opposite the mesentery and near the head of the pancreas, forming a stitch (purse-string) one third less than the length of the proposed opening into the gut; this is repeated in connection with the gall bladder, and in both viscera the sewing is like that in Fig. 944. Make an incision in the intestine equal in length to two thirds of the diameter of a Murphy button of proper size (three quarters of an inch); grasp and introduce sidewise one cup of the button (Figs. 940 and 941) and draw the suture tightly around the hub and tie it; aspirate the gall bladder and introduce a similar suture at its most convenient aspect; incise the gall bladder, cleanse it and introduce the remaining cup and tie the suture as before; invaginate the hubs (Fig. 1178) and press the cups firmly together; cleanse the parts, return them, and close the abdominal wound. In the employment of the Murphy button the gall bladder, if much distended, should be treated before the intestine, for the sake of greater convenience and safety. The opening into the former should be so placed as to readily meet the intestine without

the distortion of either.   Careful isolation should be practiced to prevent
the danger of infection incident to removal from the gall bladder of cal-
culous and inflammatory contents.   The male portion of the button can be
employed in the duodenum more conveniently than in the gall bladder.

The Remarks.—The serous surfaces to be approximated are sometimes
scratched to hasten the union.   The small button constructed by Murphy
for this especial purpose has no rival in the surgical armamentarium.   The
bone bobbin of Robson can be used with promptness and security.   In the
absence of special mechanism the union may be established by sewing, the
same as in intestinal anastomosis and implantation.   The anastomosis with
the duodenum conforms to the natural entry of bile to the intestine better
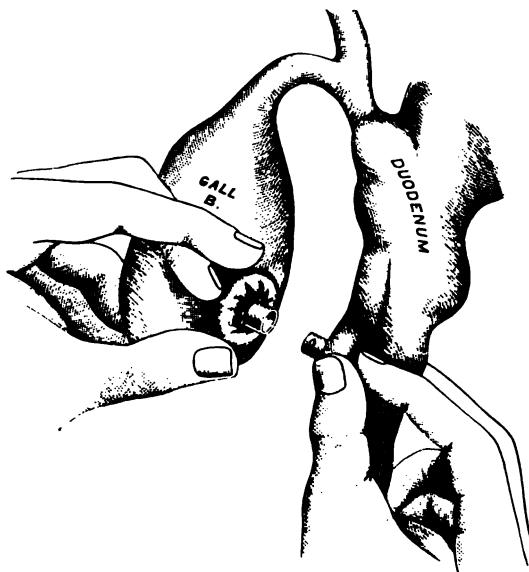
Fig. 1178.—The operation of cholecystenterostomy with Murphy's button.

than an anastomosis with any other portion of the gut.   However, whether
the increased difficulty of adjustment with this intestine in some instances
is met by a corresponding physiological gain is open to reasonable doubt.
Anastomosis with the flexure of the colon is very convenient, and thus far
has seemed quite satisfactory.   Anastomosis with the jejunum and ileum
can be readily practiced, but the mobility of these intestines is such as to
invite kinking and undue traction, to say nothing of volvulus.   However,
the extent of the adhesions that may be present in connection with the avail-
able intestines and the gall bladder, the time required for the union, and
the prospective injury attending the operation should be given as full
thought as possible at the beginning of the effort.   In the instances of
malignant obstruction early operation should be practiced, otherwise a fatal
outcome may follow imperfect adhesive repair.   Robson's bone bobbin,
McGraw's ligature, and, in fact, all anastomotic agents are safer in these
cases when supplemented with fortifying external sutures.   This procedure

ought not to be regarded as a substitute for choledochotomy, since the latter operation re-establishes normal function while the former establishes an abnormal channel which may lay the foundation for early and for future trouble from ascending infection. Moreover, the comparative difficulties and dangers of the two operations are not now so unlike as formerly, due to improved technique of the latter. That infection may reach the liver through the opening into the gall bladder, the author has occasion to know.

The Results.—Of 177 cases, 27 (14 per cent) died. Only in one case may the fatal outcome be attributed to the use of the button. In 23 cases treated by suture alone, 8 died. The death rate from other means than the button is about 35 per cent for all causes.

Cholecystenterostomy can be practiced by means of sutures only, in one, two, and three stages. In either instance the abdominal incision is usually vertical, three or four inches in length, and located at the upper limit of the right linea semilunaris. In the first instance the gall bladder is brought into the wound, isolated, and the contents are evacuated, the wall is incised for half or three quarters of an inch, the cavity irrigated with an aseptic solution, packed with a sponge and returned to the abdomen. The duodenum or jejunum, usually the latter, is brought into the wound, the contents are pushed aside with the finger, and confined there by means of broad silk traction loops passed around the intestine. A longitudinal opening of half or three fourths of an inch is made in the intestine opposite the mesentery, the gall bladder is returned to the wound, the sponge removed, and the borders of the incisions in the respective viscera are approximated and joined together by two rows of sutures, the inner uniting the mucous borders, the outer the musculo-serous coats, in the usual manner. After removal of the commanding traction sutures the parts are cleansed, returned to the abdomen, and the incision is closed in the usual manner.

In operation by two stages the gall bladder and loop of intestine are brought into the wound, and contiguous areas of each, an inch long and half an inch wide, are apposed and joined at their margins by sutures including the serous and muscular coats of the respective viscera. The approximated viscera are then returned and stitched to the bottom of the abdominal wound, and the wound itself packed with gauze for five or six days. The approximated structures are then raised upward sufficiently to permit the making of an incision into the intestine, a short distance below the united surfaces, when, with a knife or cautery passed through the opening, an anastomosis is made by freely opening the apposed areas of the respective organs. The divided borders of the mucous membranes of the structures are united with a fine continuous silk suture, the incision in the intestine is closed in the usual manner, the parts are thoroughly cleansed, returned to the belly, and the abdominal wound is closed.

In operation by three stages the gall bladder and small intestine are sewed together as in the preceding. The gall bladder is then drawn into the wound, incised, and contents are evacuated, the margins of the gall bladder are united to those of the abdominal incision, the excess of the abdominal wound is closed, and dressings are applied for several days; thus a biliary fistula is established. Through the fistulous opening the partition between the

gall bladder and the intestine is divided with a knife, and the borders are sewed as before, thus completing the second stage. After three or four weeks the fistulous opening is closed by a plastic operation, thus completing the case.

The Remarks.—This method is proper in the absence of accepted mechanical means of practice. In both plans entero-anastomosis lessens ascending infection, and isolation of the proximal part of the loop reduces the danger to a minimum.

Cholecysto-lithotrity consists in exposing the gall bladder and crushing calculi contained within it by means of the fingers, and by forceps with blades protected by rubber (Fig. 1176) or other suitable agents. The fragments are then forced through the cystic into the common duct, and thence escape into the intestine. In the instance of soft and pasty stones this plan of action may be regarded with comparative favor. But, when the stones are hard and the fragments irregular, the danger of so bruising the gall bladder as to cause subsequent ulceration and perhaps sloughing of its wall, followed by peritonitis, seems to forbid a general application of the plan.   Finally, it is not at all certain that the fragments can be pushed through the cystic duct, for Brewer has shown, in this connection, that even " a soft metal probe " can not be passed through the cystic duct in eight per cent of the cases containing calculi in the gall bladder. In the light of the present knowledge of the causes of gallstones in the gall bladder and the great gain in all respects from early drainage of the organ, if for no other reasons, this plan of practice can not be wisely commended.

The Results.—Robson reports two cases, both successful, by this method.

Cholelithotrity.—Cholelithotrity signifies the crushing of gallstones in the biliary ducts. Courvoisier and Fenger have given painstaking consideration to gallstones in its practical aspects. The stone is found at the duodenal end of the duct in 67 per cent, at the hepatic end in 15, and at the middle in 18 per cent of the cases. One stone is present in two thirds of the cases; in one third, two, and even as many as six may be found. In the instances of single stones the size varies from one to four fifths of an inch in diameter. In 97 cases of cholelithiasis stone was present in the gall bladder alone in 81 per cent, in the gall bladder and common duct in 10, and in the common duct alone in 5 per cent of the cases.

The Operation.—After thorough aseptic preparation, make either a vertical incision four or five inches in length from the ribs downward through the outer fibers of the rectus abdominis, or an angular one, with an upper limb three inches in length lying close to the ribs, and a lower one of about the same length running in the course of the fibers of the external oblique. The latter method of entrance affords a good chance for observation; neither method offers any special inclination to weakness of the abdominal wall. A straight incision beginning an inch below the eighth costal cartilage and passing through the outer border of the rectus muscle to a point two inches above the umbilicus, or a curved one beginning at a point just below and outside the ensiform cartilage and passing downward and outward parallel with the costal border to a point half an inch above the tip of the eleventh rib, will in either instance expose to division only the ninth nerve. Robson's incision (Figs. 1061, h, 1062, h') is the most available of all, and his method

of exposure of the duct to manipulation is excellent. The flaps are drawn apart with traction sutures and spatulæ, and the gall bladder is localized, from which the cystic, hepatic, and common ducts, are traced in their order and carefully examined for stone. Large stones can be easily located; small and floating ones are difficult to detect and may escape the notice of the most expert manipulation. If the stone be movable, it may be pushed along the common duct into the duodenum with the thumb and finger. If in the cystic duct, it may defeat removal by prompt escape to the hepatic duct. If the stone be fixed in the common duct, isolate the field of action from the peritoneal cavity, liver, and intestines, by careful and abundant sponge or gauze packing; raise upward the free border of the liver to afford ample view, then crush the stone by thumb-and-finger pressure, or by flat forceps with each blade covered with rubber tubing (Fig. 1176) (*choledocho-lith-otrity*) ; or, failing with these, *Tait's* plan of picking the stone into suitable sized pieces, for escape, with a sharp needle passed through the wall of the duct, can be practiced. During the latter expedient the stone is grasped with the thumb and finger to prevent its escape, and also to estimate and oppose the force applied by the needle. If the stone be not too large or too hard, but little harm can come from these means of treatment. After crushing, the operation field is cleansed, the sponges or gauze are removed, and the abdominal wound is closed, if there be no doubt as to the final integrity of the duct. If such a doubt be present, iodoform gauze tents are carried above, behind, and below the seat of the injury, and allowed to escape from a narrowed abdominal wound, remaining for two or three days, after which they are removed, leaving a fibrinous track for the escape of bile. The usual aseptic dressings are applied and anodynes administered for the relief of pain.

The Precautions.—Incautious or misdirected manipulations addressed to a movable stone located in the cystic or common duct may cause the stone to disappear instantly into the hepatic duct beyond the reach of human resource to catch, and for the time defeat the purpose of the operation. The author has encountered an instance of this kind in a stone of the cystic duct in a case of cholecystostomy. The employment of too great pressure may cause laceration of the duct, or a bruising that will be followed by the sloughing of its walls. The needle puncture of the duct should be limited to as few points as possible, and the duodenal aspect of the stone should be attacked first when practicable, to hasten the removal of the fragments. Guarded pressure should be made to prevent the needle from transfixing the duct and passing into the tissues beyond. If the duct be sacculated these methods are objectionable, as detritus may remain in the expanded part and lead quite promptly to the development of another calculus (Fenger).

The Remarks.—The gall bladder may be atrophied and inflammatory changes may have caused derangement and matting of the tissues to such an extent as to perplex the surgeon. However, if the foramen Winslowii be patent, the introduction into it of the index finger will bring the common duct between the finger and the thumb, and thus enable one to manipulate the duct its entire length (Fig. 1179). The earlier experience in this method has been superseded largely by choledochotomy, except perhaps

when the stone is crushed for removal before or after incision of the common duct. The leaving of fragments and the damaging of the tube in crushing were found to be highly objectionable in many instances. The washing out of the detritus in the common duct through an opening made into the gall bladder (cholecystostomy) is efficient, but need not be done in addition to the drainage attendant on choledochotomy, except in instances of infective cholecystitis.

The Results.—Waring reports 11 operations, of which 8 were successful. *Robson* reports 26 cases, all of which were successful.

Choledochotomy (*Choledocho-lithotomy*).— Choledochotomy consists in cutting into the common bile duct for the purpose of removing a gallstone. The cystic (*cystico-lithotomy*) and hepatic (*hepatico-lithotomy*) ducts can be opened for the same purpose and in a similar manner, and therefore can be regarded under the same heading.

FIG. 1179.—*ha.* The hepatic artery. *d.* The common hepatic duct. *pv.* Portal vein. *vc.* Vena cava. The arrow is in foramen of Winslow.

The abdominal incision, localization of the stone, etc., are somewhat similar to like steps in the other correlate operative procedures. Since the exposure of the common duct in its entirety is perhaps of greater practical importance than that of the other gall-carrying structures, we are prompted at this time to enter more fully into details regarding the importance of the position of the patient, the course of the incision, and the aid of special manœuvres in this operative procedure. *Robson* recommends that a sandbag 18 inches long, 6 inches wide, and 3½ inches deep, covered with flannel, be placed beneath the patient at the level of the liver, thus pushing forward the spine and bringing the common and the hepatic ducts several inches nearer the surface. This posture increases the space at the costal angle and also causes the intestines to gravitate downward. The turning up of the costal border (page 1002), the carrying of the liver upward and forward by means of the hand passed between the convex surface of this organ and the diaphragm, or by passing the hand below it and lifting upward and forward, and the drawing of the ducts forward by traction on the gastro-hepatic omentum by means of a finger passed through the foramen of Winslow (Fig. 1179), are each measures of importance in one's efforts to render more accessible to sight and manipulation the vessels and ducts of the liver. In cases with jaundice, remedies affecting the power of coagulation of the blood ought to be administered (page 66, vol. i). The gall bladder, cystic, and common ducts should be examined carefully in the order mentioned, the last noted especially in its relations with the head of the pancreas and inner aspect of the descending portion of the duodenum.

The Operation.—After thorough aseptic preparation make a vertical incision upon the middle of the rectus abdominis muscle, parallel with the fibers, which are then separated down to the posterior layer of the sheath; make an incision two or three inches long through the posterior sheath into the peritoneal cavity, through which the need for a larger one is determined, carry the upper end of the incision along the right costal bor-
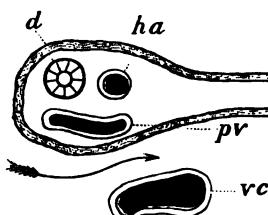
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der toward the ensiform cartilage (Fig. 1061, *h*) as far as needed for ready exploration of the common, the cystic, and the hepatic ducts; force the liver and ducts forward by means of the special expedients already expressed (page 993), aided by cautious traction on the gall bladder; note how the ducts, the head of the pancreas, and the duodenum, the former made prominent by change of position and traction, provided restraining adhesions be not present. As soon as the calculus is located in the common duct, the lesser omentum and the duct are drawn into the abdominal wound and the field of operation is isolated thoroughly with gauze pads. Seize the duct with the stone by the thumb and finger; make an incision down upon the stone in the long axis of the duct of sufficient length to permit its dislodgment; raise the stone out with forceps or scoop and remove it; wipe away the escaping bile and blood carefully; introduce a probe through the opening into the duct and sound it in either direction for the presence of other stones; pass the probe into the duodenum to insure the patency of the duct; cleanse again the field of operation; close if practicable the incision in the duct by means of two rows of fine sutures, the first including the wall down to the mucosa, the second the serous covering only. *Halsted,** in

FIG. 1180.—The operation of choledochotomy, Halsted's method. Traction loops at the sides of longitudinal incision.
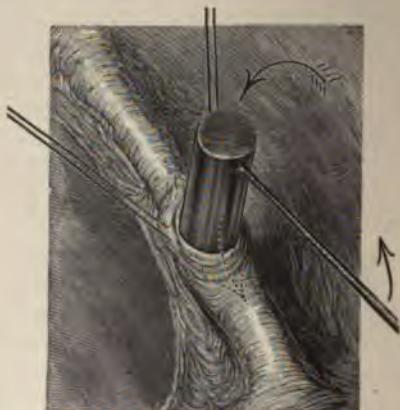
FIG. 1181.—The operation of choledochotomy, Halsted's method. Introducing the hammer.

commenting on suture of the bile ducts, expressed himself as follows: "Surgery of the common bile duct is still in its infancy." Further along, in speaking of the utterances of others regarding the "great difficulty" and "impossibility of sewing the duct," he brought to the attention of the profession the use of the hammers devised by himself for the purpose, saying, "If properly employed, they convert one of the most difficult operations in surgery into quite a simple one." *Halsted* exposed the duct at the site of the proposed incision, preferably nearer the duodenal end because of the greater convenience and better opportunity to explore the diverticulum of

* Johns Hopkins Hospital Bulletin, April, 1898.

Vater thus afforded. Two traction loops are then introduced through the walls of the duct, one at either side (Fig. 1180), the duct is incised longitudinally between them, the stone removed, the duct raised from its bed, and the incision opened by the traction loops; the hammer is introduced (Fig. 1181), pressed downward, the duct raised by traction loops, and mattress
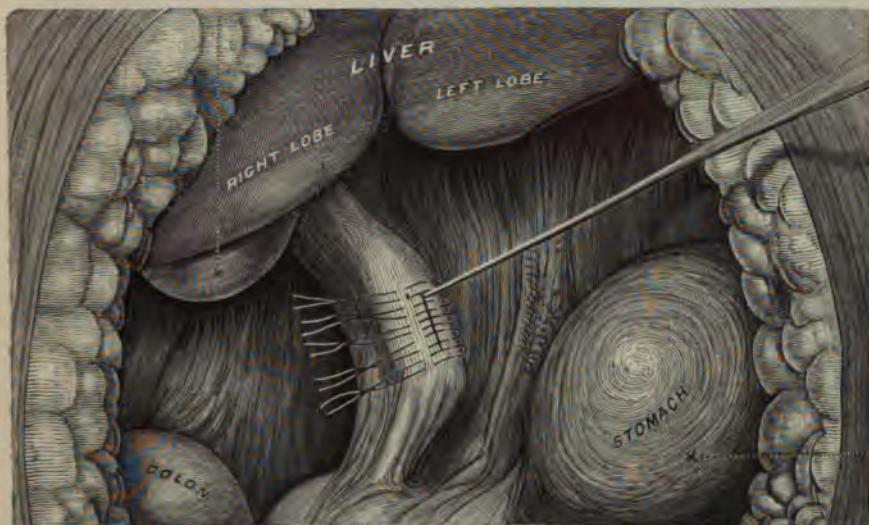
Fig. 1182.—The operation of choledochotomy, Halsted's method. Mattress sutures placed and hammer in position.

sutures are applied, one over the heel of the hammer, the remainder at the opposite side of the handle (Fig. 1182).

The advantages of the hammer are thus expressed by Halsted:

" 1. The duct to be sutured can be drawn toward the incision in the anterior abdominal wall and within easy reach of the operator; it can also be manipulated nicely by the hammer.

" 2. The duct, whether normal or thickened and dilated, is gently expanded by the hammer; hence the stitches can be taken with great accuracy and without fear of including the opposite wall or of occluding the lumen of the duct.

" 3. The operation is a very clean one, because the hammer blocks the duct and this prevents the escape of its contents and the contents of the gall bladder.

" 4. With the hammer, wounds of thin normal ducts can be easily and almost infallibly sutured, and hence the surgeon may, if he chooses, fearlessly operate upon the common duct as soon as the obstruction takes place.

" The sewing of the thickened and dilated ducts is also greatly facilitated by the employment of the hammer."

The silk, the needles, and the needle-holder are each especially provided for the operation (Fig. 1176). A series of hammers with long delicate handles are included in the outfit.

If the walls of the duct be insecure for any reason, or the condition of the patient forbid prolongation of the operation, or evidences of liver or hepatic duct infection be present, sewing should be omitted and drainage provided instead, by tying firmly into the duct a small rubber or glass drainage tube, around which throughout is carefully placed omentum, or rubber tissue and iodoform gauze, or peritonæum so adjusted to the tube and the duct as to prevent escape of bile into the peritoneal cavity, and at the same time provide for thorough drainage. The difficulty, pain, and disturbance of parts so often attending the withdrawal of iodoform gauze from the tissues, suggests that this form of gauze be dispensed with when practicable and that rubber tissue be substituted. If this gauze be employed, the objectionable features can be remedied by saturation with sterilized oil before introduction and again before removal, or perhaps quite as well by interposing between the gauze and the raw surfaces rubber tissue. *Abbe* introduced into the hepatic duct through the opening in the common, a drainage tube, over which a larger tube was passed up to the opening in the duct, and outside long strips of iodoform gauze were lightly introduced

FIG. 1183.—The operation of chole-dochotomy. A plan of drainage practiced by Abbe.

(Fig. 1183). The inner tube was removed on the second day, the outer on the fifth, the bile passing through them during their presence in the wound. The sinus closed finally in three weeks. Approximation of the borders of the incision with a single suture, or by gauze pressure plus the properly adjusted gauze drainage, answers the purpose quite well indeed. Under all circumstances some form of drainage should be employed and the external wound should not be finally closed until all danger of biliary discharge has disappeared. *Morison* advised drainage through a punctured wound carried posteriorly below the kidney. *Fenger* regards the introduction of the tube into the incision and the insertion of gauze drainage above and below the tube as quite sufficient. *Kehr* in two cases opened the abdomen in the median line between the xiphoid cartilage and the umbilicus, to remove from the cystic duct gallstones that resisted removal from below through a previously existing mucous biliary fistula. The wound of the duct was closed at once and drainage secured through the already established fistula. The presence of an impacted stone in the environment of the duodenal end of the duct or in the ampulla of Vater often requires incision of the wall of the gut to secure its release (duodeno-chole-dochotomy).

The Precautions.—Infinite care should be exercised in the detection of the site and exposure of calculi, otherwise the contiguous vessels will be

damaged or opened; and especially is this true when extensive adhesions
with consequent displacements are present, notably so near the duodenal ex-
tremity. In the latter instance the gut should be carefully pushed aside and
the wound deepened by blunt dissection. The colon may be invaded in rare
instances. Incisions into the cystic duct should be made either at the ante-
rior or posterior surface, to avoid the cystic artery (Fig. 1174) and portal
vein. The security of the hepatic artery and portal vein requires that inci-
sions be made in the long axis of the remaining biliary ducts (Fig. 1175).
It should not be overlooked that, although healthy bile is aseptic, the influ-
ences incident to the presence of calculi in the ducts may establish infection
of a serious nature, causing peritonitis, *therefore careful arrangement of
gauze at all aspects of the wound* should be made to prevent peritoneal extrav-
asation of bile. If the escape of bile into the peritoneal cavity be free it may
invade Douglas's pouch and require removal by means of a tube introduced
through an opening made above the pubes. According to *Morison* it read-
ily collects in the limited space between the right lobe of the liver and the
colon, from which it may be efficiently drained by a curved incision extend-
ing from a little below the tip of the ninth rib to the loin, and even to the
outer edge of the quadratus lumborum muscle if additional space be re-
quired. After three or four days the gauze may be removed and the rubber
tube allowed to remain for a week or so longer. The fibrinous canal formed
along the course of the gauze will meet the additional requirements
of drainage.

The Remarks.—Either the continuous or interrupted varieties of sewing
of the duct can be employed; usually the former is selected. Fine, strong
catgut or silk, and sometimes both are used, the catgut being employed for
the first row in the latter instance. Many surgeons rely on a single row of
sutures only.   Fine curved round needles and a long needle holder are the
best of the common varieties for use in sewing (Fig. 1176, *a*). Siphonage
is applied not infrequently to the drainage tube, but the action is so fickle
and so easily disturbed as to render it of uncertain utility. The removal of
the gall bladder (*cholecystectomy*) together with a portion of the duct con-
taining a calculus so firmly impacted that it can not be wisely dislodged by
manipulation upward or downward is advisable when the structural changes
in the duct at the seat of impaction are such that incision (*cystico-lithot-
omy*) is quite sure to be followed by obliteration of the duct and consequent
distention of the gall bladder by its mucous secretion. However, if the walls
of the duct are sufficiently healthy to permit proper closure of the incision
by sewing, this latter plan is commendable. Sewing is practiced much less
and drainage much more frequently now than formerly because of the
desire to eliminate promptly infection by drainage. If the gall bladder be
distended aspiration of it before incision of the duct will lessen and perhaps
obviate overflow at the seat of incision. Pressure on the duct above the
stone with the fingers, before the incision is made, will prevent the free
escape of bile when the stone is removed (Fig. 1184) ; and at this time the
patency of the duct beyond can be determined with a probe, and also the
sutures may be laid before the stone is raised from its bed (Elliot). Trac-
tion loops introduced at either side of the duct (Fig. 1180) before making

the incision are of great use in the introduction of the sutures. However, one should cautiously observe before the opening is closed that no calculi remain behind. Occasionally an obstructed common duct becomes very much overdistended, sufficiently, in fact, to cause a tumor of pronounced character. In a case of this kind, *Winiwarter*, through an incision in the linea semilunaris, established a communication between the dilated duct and the cutaneous surface (*choledochostomy*) (page 1000).

FIG. 1184.—The operation of choledochotomy. Compression of duct, exposure of stone, and placing of sutures.

Duodeno-Choledochotomy (McBurney).—In this operation the gallstone is removed from the common duct (diverticulum of Vater) through an incision made into the duodenum.

The Operation.—Place the sandbag under the lower dorsal spines; grasp with the thumb and forefinger the termination of the common duct and the corresponding portion of the duodenum; cut through the duodenum anteriorly in such a manner as to expose internally the posterior wall of the duodenum at the mouth of the common duct (Fig. 1173); open the duct by way of the papilla or the posterior wall of the duodenum and remove the obstruction; wipe away the bile cautiously to prevent infection; cleanse the parts carefully and close the opening into the duodenum with sutures in the usual manner.

The Remarks.—This incision of the duodenal orifice permits other stones to pass readily. Obstruction from tumor and stricture may be relieved in a similar manner. The pancreatic duct (Fig. 1173) may be exposed by this route (Robson).

The Results.—Robson reports 15 cases of this operation with 3 deaths. The last 9 operations were successful. Twenty-nine cases are elsewhere reported with 2 deaths.

Retro-duodenal Choledochotomy (Berg).—Make a vertical incision through the posterior parietal peritonæum at the right of the descending part of the duodenum, thus mobilizing the bowel and permitting the turning inward of it so as to expose to view the post-duodenal and papillary portions of the common duct, when the involved part of the duct is seized with the thumb and finger, the duct incised, and stone removed, followed by repair of the opening.

The Remarks.—This method was devised as a substitute for the anterior plan, and is theoretically regarded as the safer of the two, a fact that experience alone will determine.

Choledochotomy (*Lumbar Route*).—Posterior or lumbar choledochotomy was studied from its theoretical side by Tuffier and Poirier (1895).

The lumbar route has been practically utilized in man by Wright, Mears, Lange, Bogajesky, and several others.

The Operation.—Place the patient on the left side, raising the right by a cushion under the flank; make an incision over the right lumbar region, as in extirpation of the kidney. Expose the kidney and colon, isolate the upper extremity of the kidney, and raise and hold it against the false ribs by the fingers or a retractor; seek for the duodenum, first exposing the ascending portion, then the second portion, and finally the pancreas. Carry inward and shield the vena cava inferior, while the second portion of the duodenum is pressed outward; introduce the left index finger into the wound, pulp inward, and expose the " vasculo-biliary mass " as it descends from the liver (Tuffier), or obtain a view of the bottom of the wound, and locate and isolate a large cordlike mass descending from the liver toward the duodenum, consisting of two or three lymphatic ganglia, large veins, the posterior branch of the pancreatic-duodenal artery, and the gall duct. In either instance isolate and denude the duct in its retro-duodenal and intrapancreatic portion, by the aid of long forceps and a grooved sound, as far as possible without opening the peritonæum. Determine the situation of the calculus and incise the biliary canal. Remove the calculus, cleanse the parts, and otherwise treat the case as before practiced.

The Complications.—The kidney may give rise to obstacles, especially if it is a movable kidney, which often occurs on the right side. In elderly women a degree of superfluous fat may render difficult the localization of the short portion of the duct. But, as the operation would naturally be performed for a calculus, the latter would assist in the recognition of the dilated duct. In working at such a depth there is great danger of accident, especially of opening the portal vein (Fig. 1175). It is evident that when the second part of the duct is alone attacked the operation is extraperitoneal, which is a great advantage, doing away with the need of intraperitoneal sutures.

The operation is comparatively impracticable and unsatisfactory, and ill-adapted to the exigencies of surgical practice. The biliary passages as a whole can not be explored by the lumbar route. This form of intervention can be defended only in those cases where it is necessary at all hazard to reach the duct without going between the liver and duodenum.

The Remarks.—As we now have an excellent way of reaching the duct from in front, the operation of lumbar choledochotomy should not be attempted except for some special purpose. *Tuffier* recommends the incision employed in lumbar nephrectomy—one finger's breadth below and parallel with the twelfth rib. *Poirier* says the incision should be carried to the iliac crest. The second part of the duodenum is identified by the absence of peritonæum on its posterior surface.

The Results.—Of 238 reported cases, 40 (12.8 per cent) terminated fatally. *Kehr* reports 84 cases, with 31 deaths; *Mayo* 59 cases, with 3 deaths, and *Robson* 88 cases, with 5 deaths.

Choledochostomy.—Choledochostomy is the draining to the surface of the abdomen of a dilated bile duct. The technique of the approach and **repair** is quite that of choledochotomy and *hepaticostomy* (page 976).

The Results.—Infection of the liver ducts from previous dilatation and from exposure from without through the cutaneous opening invest the operation with a grave outcome. *Robson* reports successful cases.

Choledocho-enterostomy can be done with buttons of small size, such as those used by Boari in uretero-anastomosis (Fig. 1185) in a choledochus
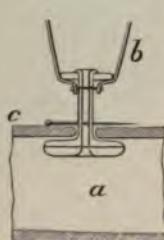
FIG. 1185.—The operation of choledocho-enterostomy, Boari's button in position, transverse section. *a.* Intestine. *b.* Common duct. *c.* Intestinal wall.
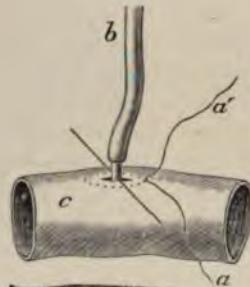
FIG. 1186.—The operation of choledocho-enterostomy, Boari's button in position. *a, a'.* End of purse-string suture. *b.* Common duct. *c.* Intestine.
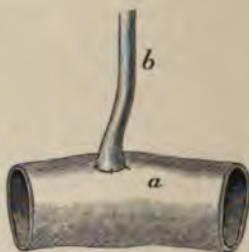
FIG. 1187.—The operation of choledocho-enterostomy, Boari's button, operation completed. *a.* Intestine. *b.* Common duct.

duct which is very slightly dilated (Fig. 1186), and this in certain cases in which it would be impossible to apply sutures (Fig. 1187).

Alessandri has recently contrived a button which is nothing more than a slight modification of Boari's. The terminal portion of the apparatus is so formed that it can be "hooded" within the stump of the choledochus duct, and the inferior portion is of an ellipsoid form. To manipulate the
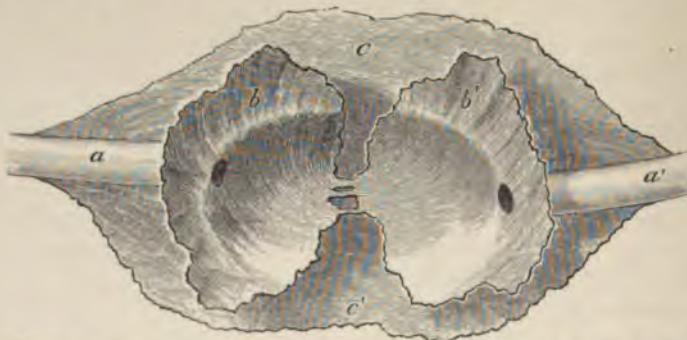
FIG. 1188.—The operation of resection-choledochorrhaphy, Doyen's method. The hepatic (*a*) and duodenal (*a'*) end of duct. The remnants (*b, b'*) of disorganized portion of duct. The flaps (*c, c'*) of peritoneal and near-by connective tissues.

apparatus the stylet which serves to separate the tissues may be round instead of ovoid or quadrangular, for in this way the button can not turn upon its axis. Besides, this button is provided at its extremity with a flange which allows it to be grasped, and which is analogous to that of an ordinary

cannulated sound. This manœuvre of introducing the sound is accomplished readily and rapidly.

Surely cholecystenterostomy is preferable to either of these procedures, provided, of course, that the cystic duct be patent. *Waring* considers the advisability of excision of a portion of the common duct (*choledochectomy*), combined with cholecystenterostomy, in localized malignant disease of the
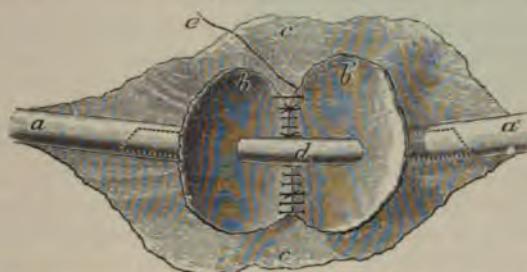
Fig. 1189.—The operation of resection-choledochorrhaphy, Doyen's method. The hepatic (*a*) and duodenal (*a'*) end of tube. The remnants (*b, b'*) of the disorganized portions of duct. The flaps (*c, c'*) of peritoneal and near-by connective tissues. *d*. The rubber tube in position.

duct or extensive papillomata of its mucous membrane and extensive ulcerative and inflammatory changes of its structure. He suggests the removal of the diseased portion by transverse division and the treatment of the divided ends by cautery or scraping. The peritonæum should then be
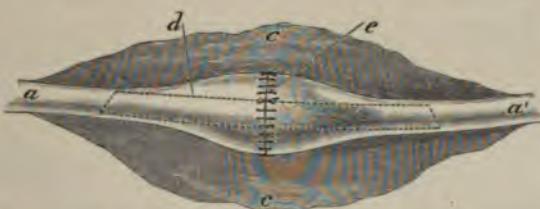
Fig. 1190.—The operation of resection-choledochorrhaphy, Doyen's method. The hepatic (*a*) and duodenal (*a'*) end of duct. The duct flaps (*d*) turned over tube and united (*e*). The flaps of peritoneal and near-by connective tissues (*c, c*).
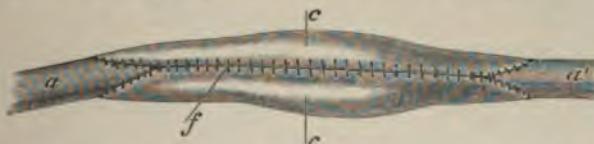
Fig. 1191.—The operation of resection-choledochorrhaphy, Doyen's method. The hepatic (*a*) and duodenal (*a'*) end of duct. The flaps (*c, c*) of peritoneal and near-by connective tissues united together and to the tube (*f*).

stitched over the space occupied by the resected part for purposes of repair of the duct and cholecystenterostomy performed. *Waring* practiced successfully on a dog this resourceful plan. Choledochectomy, like the immediately preceding operations, has fortunately but a limited though urgent field of utility.

Resection-choledochorrhaphy (Doyen).—The flaps forming the pocket which contained the calculus are utilized for the purpose of this operation (Fig. 1188).

The Operation.—After being assured of the permeability of the duct, a tube of red rubber is inserted, one half in the hepatic, the other half in the duodenal side (Fig. 1189), while the torn ends of the canal are approximated by a glover's suture (Fig. 1190). The peritoneal laminæ and nearby connective tissues are carried around the preceding suture and united (Fig. 1191), and the second suture is re-enforced by a few wholly superficial ones.

The Remarks.—This surgical attempt is cited more because of the novelty than the practicability of the endeavor. The absence of any provision for the removal of the tube and the probable opportunity to implant the hepatic end (Fig. 1185) into the intestine, followed by closure of the duodenal end, offers a rational escape from the dilemma without entertaining a serious consideration of the former plan.

The Results.—Doyen's patient succumbed on the second day. Bile had passed along the tube and no evidence of inflammation was present on autopsy.

Reynier operated successfully on a dog by this method.

Resection of the Border of the Thorax.—If, in connection with laparotomy for abdominal wounds, in exceptional cases, in operation on the hepatic ducts, and in exploration of the liver, the space is too limited for suitable
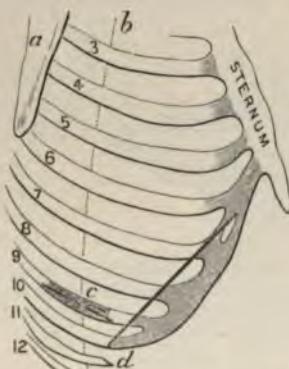
Fig. 1192.—The resection of costal border. *a.* Scapula. *b.* Axillary line. *c.* Transpleuro-peritoneal route. *d.* Incision for resection of costal margin.
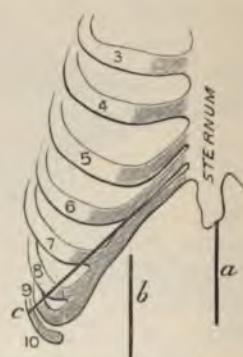
Fig. 1193.—The resection of costal border. *a.* Median line incision. *b.* Incision in right linea semilunaris. *c.* Incision for resection of costal margin.

manipulation and wise operative practice, resection of the costal cartilages may be performed (Figs. 1192 and 1193). In thoracic-abdominal wounds the transpleuro-peritoneal route may be combined with the abdominal (*c*). The forcible drawing upward of the liver, along with the costal border of the thorax, together with the support gained by the passage of the finger through the foramen of Winslow, will increase markedly the opportunities for action in gall-duct surgery. The location of the incision and the extent of the costal resection are decided by the site of the wound or of the

disease and the needs of explorative examination. After separation of the diaphragm and transversalis muscles from the costal border, it is resected and turned to suit the convenience of the operator. *Lange* regards resection as indicated in operations for gallstones where the liver is very small and located high up behind the ribs, also where the liver is enlarged, especially in fat persons and those of compact build, to facilitate access to the common and cystic ducts. In a successful case, after resection it was necessary to draw upward through the wound about a third of the liver before he could safely remove the calculus. *Halsted* speaks highly of the aid which resection of the cartilages often affords in operations on the bile ducts.

The Drainage of the Bile Ducts—Drainage through the gall bladder or the common duct is an admirable means of restoring healthy function of the liver and the ducts and forestalling the formation of gallstones. Drainage can be made through the former channel for the cure of cholecystitis and prevention of the sequels, and through the latter as a supplementary measure in the curing of infection after choledochotomy. In the former, the operative steps of cholecystostomy, and in the latter those of choledochotomy with drainage suffice for the purpose.

Biliary Fistula.—Biliary fistula not infrequently is a troublesome sequel of cholecystostomy, dependent usually on obstruction of the common duct, due to calculus and to malignant disease of the head of the pancreas. If from the former cause, the obstacle should be removed through a free incision by one of the various measures directed to the purpose. Failing in this, cholecyst-enterostomy, or implantation of the hepatic end of the duct into the intestine, may be considered. If from the latter cause, cholecyst-enterostomy offers the best solution of the problem (page 988).

OPERATIONS ON THE KIDNEYS.

The Anatomical Points.—A horizontal line corresponding in front to the umbilicus is below the lower edge of the kidney. Therefore, when the kidney extends below this line, it is either of abnormal length or is displaced downward. A vertical line, extending from the middle of Poupart's ligament to the ribs, crosses the kidney in its long axis, one third of the kidney lying to the outer and two thirds to the inner side of the line. The outer border of the erector spinæ muscle may be regarded as the superficial guide to the kidney and the quadratus lumborum muscle the deep guide, the kidney lying in front of the latter (Figs. 1194 and 1195). A line drawn from the spinous process of the eleventh dorsal vertebræ horizontally outward marks the site of the upper end of the left kidney, and a point two inches above the crest of the ilium of the same side indicates the site of the lower end. The right kidney is about half to three quarters of an inch lower than the left. The hilum lies at a point located about two inches from the median line of the back, and on a level with the spinous process of the first lumbar vertebra. It follows, therefore, that the eleventh and twelfth ribs—more especially the latter—intervene between the upper part of the kidney and the external world. Hence these ribs—particularly their

anterior extremities—may be taken as the direct guide to manipulation of
the upper part of the kidney, by pressure made directly backward from the
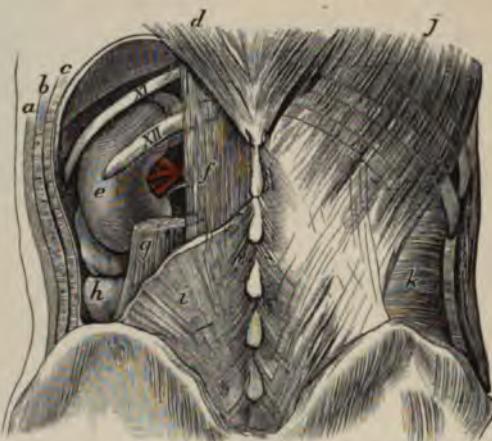
Fig. 1194.—The surgical anatomy of the left kidney. *a.* External oblique muscle. *b.*
Internal oblique muscle. *c.* Transversalis muscle. *d.* Trapezius muscle. *e.*
Kidney. *f.* Erector spinæ muscle. *g.* Quadratus lumborum muscle. *h.* Descend-
ing colon. *i.* Fascia lumborum, anterior layer. *j.* Latissimus dorsi muscle. *k.*
Transversalis muscle.

front. Parts of the duodenum and colon lie in front of the right kidney,
and the upper end is subperitoneal. The stomach overlies the upper, the
pancreas the middle, and the colon part of the lower portion of the left

Fig. 1195.—The surgical anatomy of the left kidney, transverse section. *a.* External
oblique muscle. *b.* Internal oblique muscle. *c.* Transversalis muscle. *d.* Fascia
transversalis and peritonæum. *e.* Anterior, middle, and posterior of lumbar fascia.

kidney. The upper portion, and mainly the lower, are covered with peritonæum, but the middle not at all. The renal arteries lie in front of the associate veins more often than is usually depicted. Double renal veins are more frequent than are double renal arteries. A branch of the renal artery or vein runs across the back of the renal pelvis, and small branches of the renal artery that anastomose with the lumbar vessels are close at hand. These vessels may be wounded in ligature of the pedicle.

After the tenth year, and seldom before this time, the kidney is surrounded by two fatty capsules (Keen) the thickness of which are quite proportionate to the adiposity of the patient (Figs. 1195 and 1196). *Hall* and *Lange* have emphasized the importance of the relations of the twelfth rib and pleura in operations on the kidney in no uncertain manner. Normally the lower limit of the pleura corresponds to a line extending between the lower borders of the twelfth dorsal vertebra and the eleventh rib. The twelfth rib may be absent, or so rudimentary as to escape notice, therefore the eleventh may be mistaken for it, with obvious outcome in extended operative procedure directed to the supposed twelfth rib. When this rib is rudimentary the pleura descends as low as when of normal length.

Melsome has pointed out the fact that when the twelfth rib extends beyond the outer border of the erector spinæ muscle an incision reaching to the angle of the crossing does not endanger the pleura except when the muscle is cut into or pulled aside, thus changing, perhaps needlessly, the normal relations of the parts. However, in the absence of this rib, or its failure to cross the muscle, the trusty angle is not present, but instead a deceptive one is formed higher up by the eleventh instead of the twelfth rib.

If this fallacy be not determined by previous counting of the ribs, from above downward, the pleural cavity is almost certain to be invaded. But laterally, on the left the pleura extends to within an inch and a half of the costal margin; on the right to within two inches.

Nephropexy.—Nephropexy (nephrorrhaphy) is an operation directed to the fixation of a troublesome movable or floating kidney. The former condition is quite common and usually acquired; the latter is rare and congenital. The right kidney is mobile much more frequently than the left; both may be similarly affected together, the left rarely alone.

The Operation.—Place the patient with the sound side resting on a hard pillow so as to make the field of operation convex and to increase the distance between the last rib and the crest of the ilium (Figs. 1198 and 1199); locate the twelfth rib and half an inch below at the outer border of the erector spinæ begin the incision (Figs. 1205, perpendicular C, 1194 and 1195); carry the incision downward along the outer border of the sheath of this muscle, which should not be opened, toward the iliac crest for three or four inches; divide the superficial tissues down to the posterior border of the latissimus dorsi (Figs. 1194 and 1195); draw forward the fibers of this muscle and divide the lumbar aponeurosis connected with the internal oblique and transversalis muscles down to the quadratus lumborum; ligature the lumbar arteries; push aside or divide, as necessary, the outer border of the quadratus lumborum muscle; cut through the anterior lamella

of the lumbar fascia and expose the fascia transversalis (Fig. 1196); divide
this fascia, and thus expose to view the thin outer fatty capsule; draw apart
the borders of all the divided tissues, causing the fatty capsule to project into
the wound under pressure directed upward and backward by the hand of
an assistant applied to the abdomen in front; insert the fingers into the
wound beneath the fatty capsule and draw it and the kidney farther out-
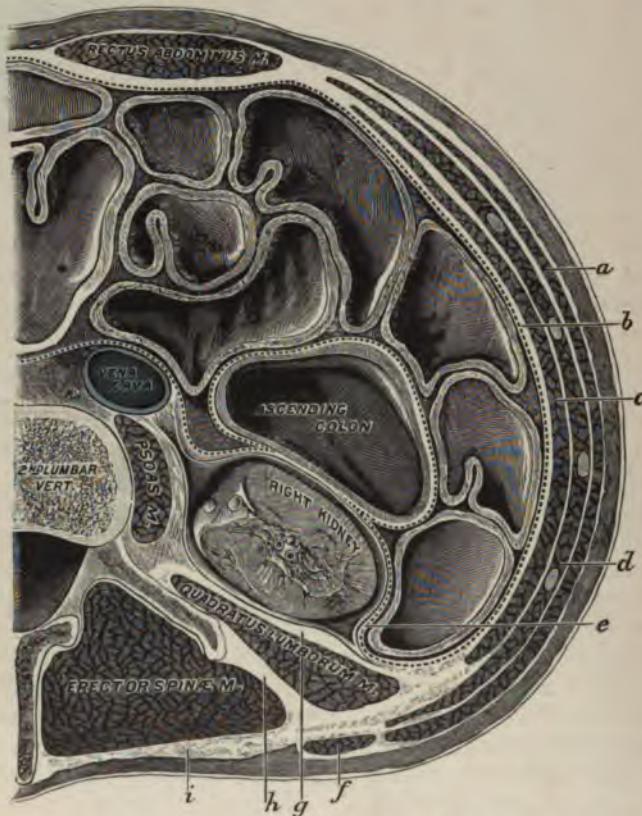
FIG. 1196.—The surgical anatomy of the right kidney, transverse section. *a*. External
oblique muscle. *b*. Peritonæum. *c*. Transversalis muscle. *d*. Internal oblique
muscle. *e*. Peritonæum. *f*. Latissimus dorsi muscle. *g*. Anterior layer of lum-
bar fascia. *h*. Middle layer of lumbar fascia lying above transversalis fascia. *i*.
Posterior layer of lumbar fascia.

ward; open the fatty capsules in the long axis of the kidney; seize their bor-
ders and carefully and evenly draw them with the kidney still farther out-
ward, thus causing the capsules to embrace the kidney snugly; from this
time one of several plans of fixation can be practiced. 1. Trim away the
superabundant fatty capsules, and sew the divided borders to the deep
structures of the wound with kangaroo tendon or chromicized catgut. In
this method the borders of the wound are approximated somewhat, and the
remaining space stuffed with gauze, which is removed from time to time,

Fig. 1197.—Instruments employed in operations on the kidney.

a. Retractor, exploring needle, probe, grooved director, and tenotome, employed in searching for calculi. *c.* Blunt hook and tenaculum. *d.* Periosteotome. *e.* Blunt dissector. *f* and *h.* Forceps for removal of stone. *i, j,* and *k.* Variously formed scoops. *l.* Kangaroo tendon in glass tube. *m.* Costotome for cutting cartilages and ribs. *n.* Curved and straight pedicle clamps. *o.* Long-bladed clamp. *p.* Searcher for stone. *q* and *r.* Direct, adjustable (Polk's), and curved ligature carriers for tying pedicle. *s.* Curved and straight needles. *t* and *u.* Long-bladed forceps for catching fragments of stone in pelvis and in ureter. *v.* Silkworm gut and chromicized catgut. Scalpels, bistouries, forcipressure, a needle-holder, silk, catgut, thumb and mouse-tooth forceps, long-handled scissors, large drainage tube, a spatula, and a uterine dilator should be provided.

with the idea of fixing the kidney in place by means of the cicatricial attach-
ments resulting from the closure of the wound by granulation. This
method can not be commended because of the low rate of success. 2. After
the fatty capsule is trimmed, divide the fibrous capsule longitudinally at
the outer border of the kidney for three or four inches; strip off the cap-
sule for half an inch at either side of the entire length of the incision; pass

Fig. 1198.—The exposure of the kidney. Incision at outer border of erector spinæ
muscle. Patient in Simon's position.

five or six chromicized catgut or kangaroo-tendon sutures at either side,
causing them to include the reflected part of the fibrous capsule, a limited
portion of the unreflected part, the kidney substance for half an inch, and
the border of the fatty capsule, with the transversalis fascia and the other
deep tissues of the wound. Three or four sutures are carried from side to
side through the transversalis and lumbar fasciæ and the superimposed
deep tissues, the stripped fibrous capsule, the unstripped near to its attach-
ment, and the kidney structure for an inch or so, and tied after approxi-
mation of the borders of the main wound with suture so as to relieve the
strain on the deeper ones. These sutures are drawn only sufficiently firm

Fig. 1199.—The exposure of the kidney. Incision at outer border of erector spinæ.
Patient in Lange's position.

to approximate and hold the various structures in position while union takes
place. The technique of fixation is variously modified, and is quite too ex-
tended to be presented in detail. It is sufficient, as it seems to us, to indi-
cate that the kidney can be anchored to the borders of the abdominal wound
by one of the following plans, with varying results (page 1017) (Delvoie):
    (a) Suture of the fatty capsule to borders of wound.
    (b) Suture of the fibrous capsule.

(*c*) Suture of the parenchyma without stripping of the capsule.

(*d*) Suture of the parenchyma after stripping of the capsule.

(*e*) In any instance the kidney should be pushed into the wound before fixation.

(*f*) Special methods of practice.

Senn's Method.—*Senn*, after exposure of the kidney through the vertical incision, divided and removed the fatty, and scarified the fibrous, capsule

Fig. 1200.—The operation of nephropexy, Senn's method. Showing sling of gauze around upper end of kidney.

freely with cambric needles held by forceps. He passed underneath the upper extremity of the kidney a strip of iodoform gauze twelve inches long and two inches wide, placing a gauze pad over the exposed portion of the

Fig. 1201.—The operation of nephropexy, Senn's method. Showing sling of gauze and pad.

kidney (Figs. 1200 and 1201), and carrying a sling of gauze around the kidney, fastened it in position over the gauze pad. He introduced two

68

sutures into the upper angle of the wound, leaving them untied. He then packed around and beneath the kidney abundant gauze, and placed and bound in position over the right hypochondrium a pad of sufficient dimensions to re-enforce the gauze supports.

The wound was redressed in three days and the secondary sutures tied. The packing beneath the kidney was removed in six days after the operation, and the gauze sling in eleven, exposing to view in each instance freely granulating surfaces, which were maintained in contact with each other by means of adhesive strips carried around the body, and which at the same time narrowed the external wound. In this operation the patients should be kept in the recumbent posture until the adhesions become substantially organized. The claims made by Senn in support of this method of practice are certainly rational and prudent. He says: " 1. An extrarenal support of the kidney is obtained. 2. This support is formed by union of the fibrous capsule of the kidney with the pararenal connective tissue; hence no interference with the kidney itself. 3. The gauze sling draws the lower pole of the kidney in an outward direction, placing the axis of the kidney at an oblique angle. This position secures support from the parietal wall at the lower angle of the wound, and favors correction of flexion of the ureter, provided it be present." If the kidney is not held in proper position by the gauze sling, as illustrated, it should be carried around the lower instead of the upper part of the kidney.

Deaver removes the fatty capsule entirely from the posterior surface and to the hilum from the anterior. He passes gauze beneath the upper pole of the kidney and below the lower, allowing it to remain in place for a week or ten days. Gauze is packed around the kidney and the hypogastric compress employed as in the preceding instance. Usually the wound heals completely in four or five weeks.

Morris's Method.—*Henry Morris* fixes the kidney in the wound by means of three silk sutures passed through the fibrous capsule and kidney substance and the borders of the transversalis fascia and aponeurosis of the transversalis muscle, and tied, as indicated in
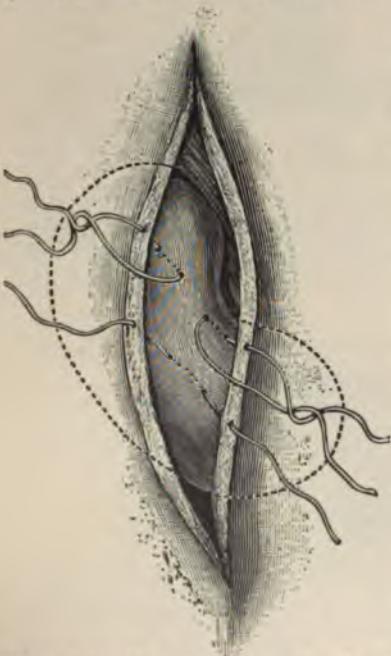
FIG. 1202.—The operation of nephropexy, Morris's method.

the illustration (Fig. 1202). The wound is closed at once and the patient kept quiet in bed for three or four weeks. Morris has practiced this plan satisfactorily for many years, and consequently commends it highly. Strict asepsis should be practiced, otherwise the silk sutures will become troublesome.

Vulliet, after exposing and lifting the kidney in the usual manner, raises, through a short vertical incision of the skin and fascia, made parallel with the spinous process of the first lumbar vertebra, a slip of the tendon of the erector spinæ, about ten inches long and a quarter of an inch wide, which is then divided above, pulled out through the primary wound, and left attached below. The slip is then carried through the muscle, caused to underrun the fibrous capsule of the kidney, thence is passed backward and attached to the muscle above (Fig. 1203). *Morris* divides the slip into upper and lower portions, and passes one beneath the capsule, tying the end to the remaining part.

Franks, noting the fact that the kidney, when hardened in position, is grooved by the twelfth rib, advises anchoring the organ to that bone. Therefore the capsule is divided and reflected briefly at the place on the surface where it is proposed to pass the sutures. The flaps and the exposed kidney substance are then sutured to the twelfth rib with catgut. The patient is kept in bed for six weeks.

After fixation is completed the sutures are cut short, the deep tissues of the wound united with buried chromicized catgut sutures and the superficial closed with silkworm gut, leaving, if desired, proper space for the introduction of deep drainage. The usual aseptic dressings are applied to the wound, and a firm compress is so placed

FIG. 1203.—The operation of nephropexy, Vulliet's method.

in front as to maintain the kidney in proper relation with the wound on application of the abdominal binder.

The incision for reaching the kidney in this operation is obliquely placed by many surgeons (Fig. 1204, *a*), the obliquity being modified by the need for room. The oblique incision as commonly practiced is begun an inch below the twelfth rib at the outer border of the erector spinæ, and is carried obliquely downward and forward so as to expose the anterior border of the latissimus dorsi, and the posterior border of the external oblique. It will be seen that the lumbar aponeurosis is divided farther outward in this incision than in the vertical one, and that the quadratus lumborum is reached nearer to its outer border (Figs. 1195 and 1208). In other respects no practical difference exists. In stout patients it may be advisable to make a T-shaped incision, to afford more room and better observation. The horizontal part of this incision should be securely closed at once, irrespective of the treatment of the remaining portion.

The kidney can be readily exposed for diagnostic and other purposes without dividing the muscles, nerves, or vessels by means of the " gridiron " manner of dissection employed in operation for appendicitis. Begin the incision at the inner side of the anterior superior spine of the ilium, and

carry it obliquely backward and upward toward the tip of the last rib; split correspondingly the fibers and aponeurosis of the external oblique muscle, and draw the borders well apart; split the fibers of the internal oblique in a line extending between the ninth costal cartilage and the posterior supe-
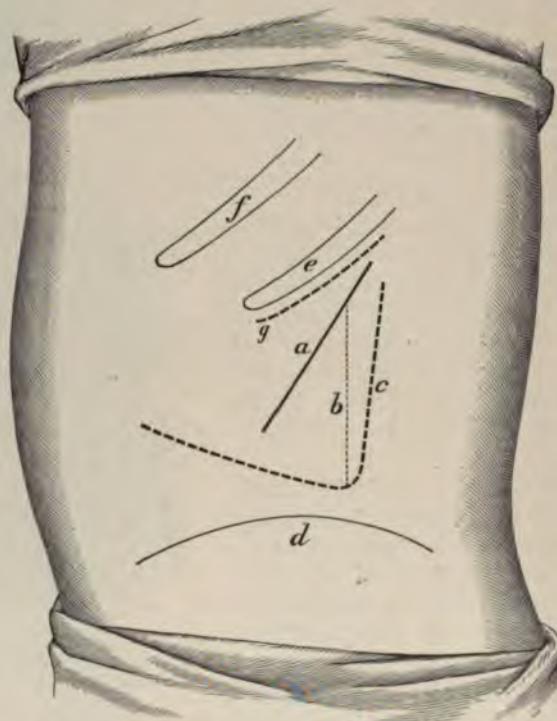
Fig. 1204.—The linear guides for operations on the kidney. *a*. Lines for incision in exploration in nethrotomy and in nephrolithotomy. *b*. Morris's secondary incision in nephrectomy. *c*. König's lumbo-abdominal incision in nephrectomy. *d*. Outline of iliac crest. *f*. Eleventh rib. *e*. Twelfth rib. *g*. Jacobson's incision.

rior spinous process of the ilium, and retract the borders, thus exposing the fibers of the transversalis muscle; split and draw apart the fibers of the transversalis, incise the transversalis fascia, exposing the subserous tissue and perirenal fat; pass the fingers through the fat, expose and raise the kidney into the wound, and anchor it according to the method of Jacobson (page 1013).

Robson commends this method of approach as being useful for divers purposes directed to the kidney. Time in operation is saved, no blood is lost, rapid and secure repair follows, and the procedure does not incur special danger nor assume the lay significance of free incision.

Tuffier's Method.—Expose the kidney through a nearly vertical incision, extending from just below the eleventh rib to the crest of the ilium, four fingers' breadth outside of the lumbar spines; remove from the convex border and the surfaces of the organ the fatty capsule; pass a thick catgut

or kangaroo tendon ligature through each end of the kidney, an inch and a half from the extremities, arranged so as to draw the organ well into the wound when tied; dissect off from the posterior surface and convex border the proper capsule of the kidney and pass a third ligature through the middle of the renal substance; fix the superior suture to the periosteum of the twelfth rib and the middle and inferior ones to the deep aponeurosis of the wound, thus bringing the denuded surface of the kidney in contact with the lumbar wall; suture the different muscular layers independently with catgut and close the wound with silkworm gut, using no drainage. Keep the patient on the back for about three weeks, with the pelvis moderately elevated and with gentle pressure so applied as to retain the kidney in place.

Jacobson's Method.—Expose the kidney through a four-inch incision, beginning about two inches and a half from the spine and running forward obliquely parallel with and half an inch below the last rib (Fig. 1204, *g*);
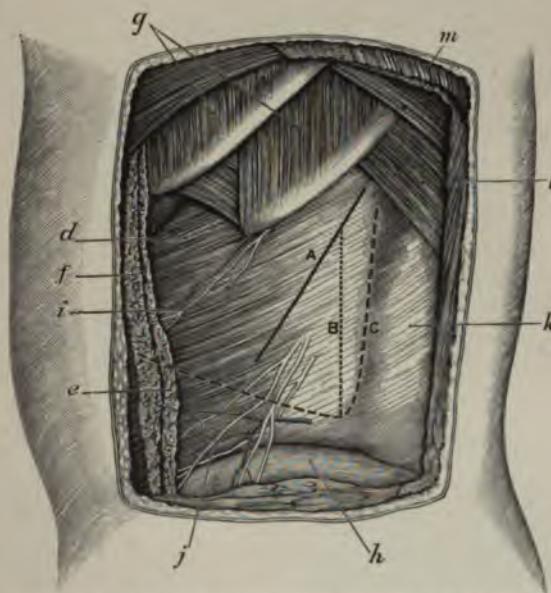
FIG. 1205.—The anatomy of incisions in operations on the kidney. *A.* Lines of incisions in exploration of kidney in nephropexy, nephrectomy, and nephrolithotomy. *B.* Morris's secondary incision in nephrectomy. *C.* König's lumbo-abdominal incision in nephrectomy. *d.* Transversalis muscle. *e.* Internal oblique muscle. *f.* External oblique muscle. *g.* Intercostal muscles. *h.* Crest of ilium. *i.* Intercostal nerve and artery. *j.* Twelfth dorsal nerve and lumbar artery. *k.* Fascia lumborum, erector spinæ beneath. *l.* Serratus posticus major muscle. *m.* Latissimus dorsi muscle.

elevate the kidney from out of the abdomen, surround it with aseptic gauze and make an incision only through the capsule along the convex border from end to end; gently strip off the capsule from both surfaces halfway across the organ; raise the flaps and unite each one by numerous medium-sized silk sutures to the aponeurotic and subcutaneous tissues of the corresponding sides of the wound, but not encroaching within the wound; arrest

all oozing, dry the wound, and close without drainage the deep part with buried chromi-gut sutures, and the superficial with silkworm gut.

Biedl-Kocher Method.—Split and strip the fibrous capsule from the outer portion of the kidney and sew the borders of the raised capsule to the corresponding deep borders of the wound. Close the upper and lower ends of the abdominal wound with sutures and pack the intervening part of the wound with gauze, causing it to rest upon the exposed uncovered parenchyma of the kidney. The amount of packing is gradually diminished, allowing the wound to heal in from four to six weeks.

Edebohls's Method.—Place the patient in abdominal decubitus upon an eight-inch cylindrical inflated air cushion (Fig. 1206); make an incision
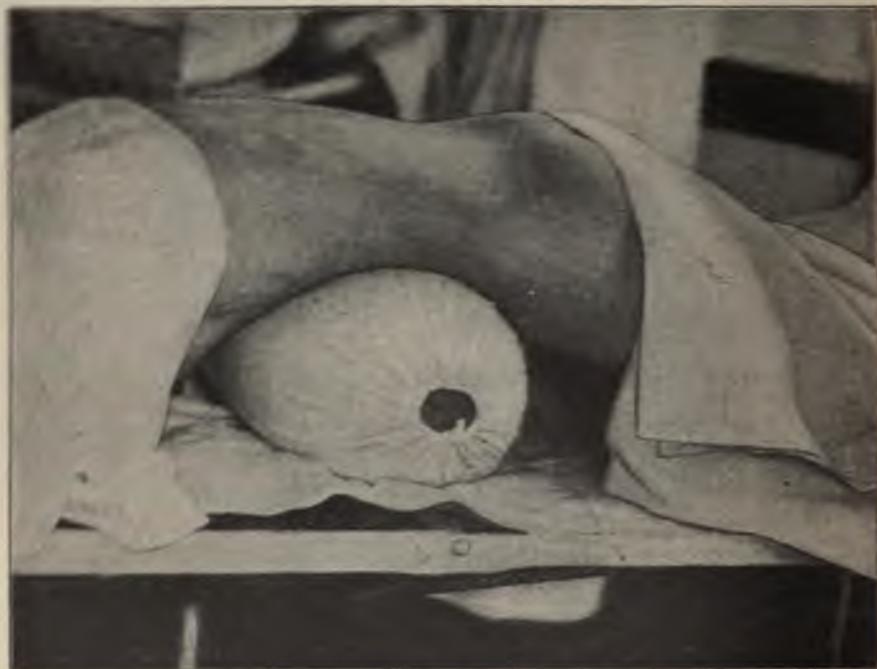
Fig. 1206.—Nephropexy, Edebohls's air-cushion, in position for operation.

from the lower border of the last rib along the course of the fibers of the latissimus dorsi muscle, at the junction of its middle and posterior thirds (Figs. 1204 and 1205), through the integument and fascia (avoiding the sheath of the erector spinæ) down to the crest of the ilium; divide the lumbar aponeurosis of the internal oblique and transversalis muscles down to the quadratus lumborum muscle (Figs. 1204 and 1205), catching and tying the lumbar vessels; separate the fibers of the quadratus lumborum, and divide the anterior layer of lumbar fascia, carefully avoiding the contiguous branches of lumbar nerves; divide the fascia transversalis and bring into view the fatty capsule of the kidney, composed of two layers (Keen); draw freely apart the borders of the divided tissues, and loosen
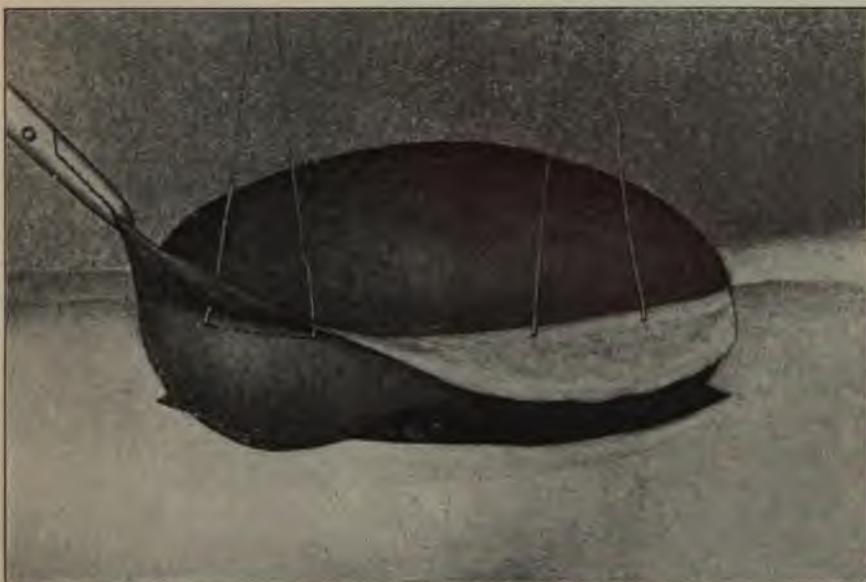
Fig. 1207.—Nephropexy, Edebohls's method. Showing suspension sutures passing through kidney capsule.

the fatty capsule from contiguous tissues by blunt dissection; deliver the kidney surrounded by its capsule through the wound; dissect away the fatty capsules and incise the fibrous one along the center of the convex border; separate the fibrous capsule from the kidney by blunt dissection at either side to the extent indicated in the illustration (Fig. 1207), removing undue

Fig. 1208.—Nephropexy, Edebohls's method. Showing sutures in abdominal wall.

amount of the same; introduce two sutures at either side through the proper capsule, as shown in the preceding illustration; pass the ends of each suture from within outward, through the abdominal wall, near to the borders of the divided tissues composing the incision (Fig. 1208); unite with buried sutures the corresponding borders of the divided tissues; draw firmly into place and tie on the surface of the latissimus dorsi (Fig. 1196) the suspending sutures, and close the abdominal wound in the usual manner.

The Remarks.—"Forty-day" chromicized catgut is used for suspension sutures. The appendix can be examined and removed at the same time through an incision of the peritonæum located at the outer side of the ascending colon, also the gall bladder and bile passages may be examined through the same opening. Edebohls latterly removes the entire capsule (page 1037).

The Choice of Operation.—We are not disposed to regard with favor operations that invade, except perhaps superficially, the kidney structure, and then, in the instances of diseased kidney, we much prefer to avoid it.

The operations that anchor the organ to the abdominal wall by means of sewing to it the reflected flaps of the proper capsule of the viscus are the ones usually practiced by us. In the methods that utilize the last rib for a special purpose one ought not to forget the liability of invading the pleural cavity. In view of the fact of apparent improvement in many cases of chronic nephritis from decortication of the kidney, the formation of flaps by this means for fixation purposes seems to be a not improper measure. *Emerson's* * conclusions regarding the effects of decapsulation of the kidney is one of great importance in this connection. The methods of practice that secure the promptest relief from confinement in bed, with a minimum of annoyance while there, are deserving of favor, provided the repair be equally effective. In instances calling for examination of the pelvis or of the structure of the kidney the flap measures are especially fitting.

The Precautions.—Carefully note the presence of the twelfth rib, and as carefully approach the upper end of the kidney in operation, fearing involvement of the pleural and peritoneal cavities. Recognition of the anterior lamella of the lumbar fascia and of the fascia transversalis (Figs. 1195 and 1196) will prevent premature search for the kidney, and may obviate delay and even defeat in finding it; it may also prevent a precipitate and perhaps unnecessary involvement of the peritoneal cavity. If the kidney be pushed too far upward before fixation, the downward movement of the liver, with breathing, will hinder proper union. In fact, profound inspiration should be interdicted for a time for a similar reason. A freely movable and a floating kidney should be approached with care to avoid unnecessary or unexpected invasion of the peritoneal cavity. If the fatty capsule is thin, a mesonephrone is present, and involvement of the peritoneal cavity by tearing of the peritonæum is liable to happen, especially if undue vigor is used in traction or other manipulations. These tears should be closed at once by sewing or ligature, depending upon the size and situation.

The Remarks.—Deep drainage should be employed when infection of the wound is suspected. Deep drainage is advised by some surgeons in all

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* Amer. Jour. Med. Science, October, 1904.

instances on account of the irritating effect on the tissues of its presence, thereby securing firmer union. However, this desideratum may be reached instead by a free scratching of the tissues before closure of the wound. The sutures involving the kidney structure are employed for the purpose of approximation, not of union of the included structures, for if drawn tightly the kidney tissue is promptly cut through. The removal of the posterior part of the fatty capsule is advised by some, in order to place the subjacent part of the kidney directly in contact with muscular tissue. Needles with sharp borders and silkworm gut ought not to be introduced into the kidney. The deeper dissections are conducted more safely by means of blunt scissors.

The after-treatment consists in keeping the patient quiet in the recumbent posture for three or four weeks. The drainage tube may be retained for some time with the view of stimulating firm repair. The contents of the bowels are kept in a soluble condition. The wearing of a body band and the avoiding of severe strain should be carefully practiced for some months.

The Results.—The results are modified very largely, indeed, by the plan of procedure practiced by the surgeon. The following statistics of *Delvoie*, relating to two hundred and fifteen cases, are exceedingly instructive, and do much to settle the best methods of procedure:

	No. cases.	Cures.	Improved.	Unsuccessful.	Relapse.	Deaths.
Suture of the fatty capsule........	14	4	3	2	5	0
Suture of the fibrous capsule	24	10	3	4	5	2
Suture of the parenchyma without stripping of the capsule.........	110	75	14	11	8	2
Suture of the parenchyma after stripping the capsule	10	9	0	1	0	0
Special methods	10	5	5	0	0	0
Operative procedures of uncertain character	47	32	5	7	2	1
	215	135	30	25	20	5

The general death rate is from 2 to 4 per cent in mixed operations. According to the older statistics of Albarran, in 374 cases 7 died within four months of operation, of which deaths 4 could be attributed properly to the operative procedure alone. In 88 per cent of these cases pain was cured; in 14 per cent nervous symptoms were partially cured, but in 36 per cent no benefit was experienced in this regard. *Edebohls* reports 1 death in 50 cases with but 2 relapses in six years. *Morris* reports 80 cases of his own, with 80 recoveries. Of 173 miscellaneous cases, 4.4 per cent died from operation (Tuffier).

Important Anatomy of the Kidney.—As Kelly says, the lobules of the kidney are more prominent and the vascular septa between them more easily seen when the pelvis of the kidney is distended than when collapsed (Figs. 1209 and 1210). *The vascular supply of the kidney has an important bearing, especially in connection with searching, incising, and sewing of the organ.* According to Broedel, the arterial supply of most of the kidneys is from two sources—major and minor—which are separated from each other by the renal pelvis. *The major source* (Figs. 1210 and 1211) sup-

plies with blood the anterior half of the kidney and half of the posterior portion (Figs. 1211 and 1212). *The minor source* supplies the remaining posterior half of the organ. It naturally follows here the same as at the median line of the tongue that the area of anastomosis between two distinct arterial supplies of an organ is the area of lowest vascularity of the organ, and therefore the least inclined to hæmorrhage when incised, and *per contra* when incision is made at either side of the neutral area the bleeding is vigorous and in proportion to the

FIG. 1209.   FIG. 1210.

FIG. 1209.—Cross section of kidney with pelvis distended. Lobules clearly visible. Vascular systems separated. Arrow indicates incision easily made into pelvis without injuring papillæ. *A*. The renal artery. *V*. The renal vein.

FIG. 1210.—Cross section of kidney in normal state of collapse. The pelvis and infundibula appears as a narrow slit at the center of the organ, difficult to incise without cutting papillæ. *A*. Renal artery. *V*. Renal vein.

vascular supply of the part invaded. Incision of the kidney in the area of major supply (usually the anterior surface) is attended with severe and sometimes fatal hæmorrhage (Kelly). The area of low vascularization lying between these systems in the normal kidney is only a few millimeters in width (Fig. 1210), but if the kidney be enlarged by distention of the pelvis with fluid, the width of the area may become 2 centimeters (¾ inch) or more (Fig. 1209). A careful examination of the surface of the kidney finds it divided into irregular areas that can be felt with the fingers (bodies of the pyramids of Malpighi), bounded by light-colored depressed lines (bases of the columns of Bertini), which latter form on the anterior sur-

face (Fig. 1212) a longitudinal white line, called by Howard Kelly "Broedel's white line."

The best course of incision of the kidney is longitudinally through the lateral portions of the posterior pyramids, parallel with Broedel's white line and also with the posterior surface of the kidney (Fig. 1213), thus dividing the kidney so that three fifths will be anterior to the incision and two fifths posterior to it.

FIG. 1211.   FIG. 1212.

FIG. 1211.—Cross section of kidney with pelvis distended, showing arrangement of major and minor arterial supply.   a. The area of low vascularization between the anterior and the posterior arterial supply.   b. The depression making border line between the anterior and the posterior row of pyramids.   c. The longitudinal column of cortical substance in which the major part of renal vessels pass.

FIG. 1212.—Cross section of kidney with pelvis distended, showing: a. The "white line."   b. The correct line of incision.   c. The incorrect line of incision.   d. The lateral cortical column.   e. The major calyx; also the arrangement of the arterial supply of the organ.

The Precautions.—If the direction of incision of the kidney be not guided by the posterior surface of the organ, but rather by the notion of the operator of the location of the pelvis of the kidney, severe bleeding will follow (Fig. 1212). In about a third of the cases the arterial supply is reversed, the major supply being of the posterior instead of the anterior part of the kidney.*   *Kelly* says that "the incision should pass parallel to the longitudinal white line, away from it, and on the side of the kidney where the palpating finger feels the lesser number of vessels; in the majority of cases on the posterior surface, but occasionally anteriorly."

* British Medical Journal, February 1, 1902.

The Remarks.—Groups of stellate vessels may be present instead of the white lines. An incision can be well made at a thin part of a diseased kidney. The gush of water following may expel a stone and save the trouble of searching for it. The pelvis of the kidney may be irrigated through the opening, with catheter in ureter.
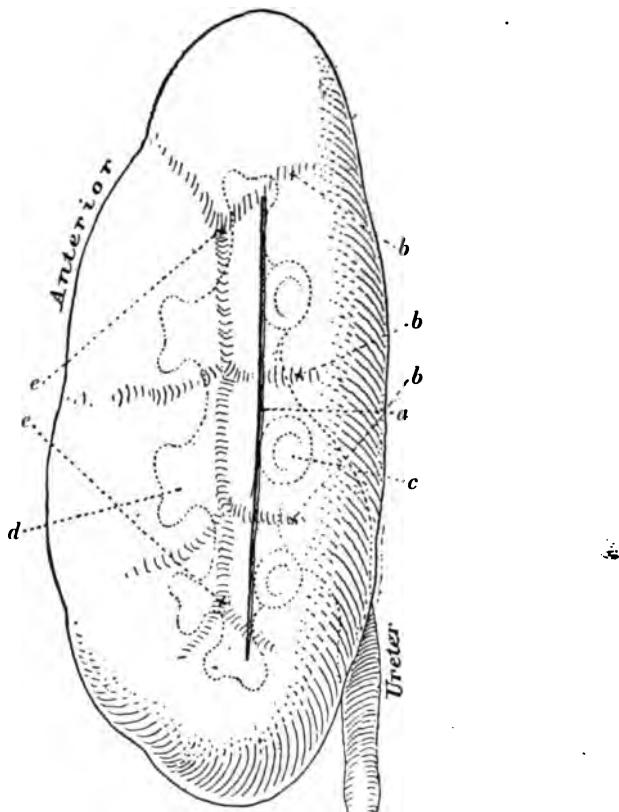
Fig. 1213.—Lateral view of kidney conforming with section of kidney (Fig. 1212) and showing the best line of incision into the organ. *a.* The best line of incision. *b, b, b.* The columns of Bertini. *c.* The posterior calyx. *d.* The anterior calyx. *e, e.* The lateral cortical column (most vascular region).

Nephrolithotomy.—Nephrolithotomy is the operation of incision of the kidney for the removal of stone.

The special instruments needed are retractors, spatulæ, a long needle with a handle, probes, small scoops, small lithotrity forceps, dressing and polypus and lithotomy forceps (Figs. 1197, *a, j, f, h*).

The kidney can be exposed by means of a lumbar or an abdominal incision (Figs. 1204, 1208, and 1101).

The Lumbar Method of Operation.—After thorough cleansing of the colon, and employment of local antiseptic measures, place the patient on the sound side and expose the kidney (Figs. 1204 and 1208, *a*) as in nephro-

pexy (page 1005). After division of the transversalis fascia expose the fatty capsule freely by wide retraction of the borders of the divided tissues; expose the kidney by dividing and pushing aside the fatty capsules; press the kidney into the wound from in front; introduce the finger between the fatty capsule and the kidney at the posterior surface, and feel for the presence of stone while counter pressure is made in front; examine the anterior surface, using firm pressure for the purpose; thrust the exploring needle (Fig. 1197, a) into raised or indurated areas of the kidney to determine the presence of stone. If nothing unusual be noted on palpation, the exploring needle may be introduced, although the procedure is regarded by Morris as being absurdly inefficient and should rather be superseded by deliberate incision. The pelvis of the kidney can be readily explored by means of a small sound (Fig. 1197, p) passed into it through a narrow incision made into the calyx at the lower end of the organ (Lloyd). The metal *bougie à boule* (Fig. 1733) is the better searcher for this purpose (Clarke). Failing with these means to find a stone, make an incision at the external border of the kidney (Morris and Kelly) (Fig. 1213), or through the wall of the pelvis itself (Thornton), through either of which examination of the pelvis can be made by the finger or an instrument. Incision at the external border is regarded as the best, since the wound bleeds less, heals more promptly, and is less liable to be followed by a fistula. The situation, size, shape, and compactness of the stone will determine the freedom of removal. If a stone be located in the cortical tissue, it should be removed through an opening made directly down upon it. If it be in the pelvis of the kidney or at the mouth of the ureter, it should be removed through the channel that leads to the discovery, if practicable, otherwise through a short incision into the pelvis at the posterior wall, made cautiously with a sharp knife. Limited incision with a narrow tenotome (Fig. 1197, a), followed by digital or instrumental dilatation and rupture, affords the safest means of gaining access to a stone. The stretched and ruptured tissue bleeds comparatively little and heals promptly, and the presence of the finger in the opening reduces the amount of hæmorrhage to a minimum. The stone is removed with the finger, aided by scoops, forceps (Fig. 1197, f, h, j), etc. If it be large, hard, or irregular, it should be broken and removed piecemeal, remembering that it is better to spoil a good specimen than to damage a kidney in endeavoring to preserve the specimen. Stones surrounded by suppurating processes are more easily removed than those that are not, and the removal should be attended with antiseptic douching. The presence of stone at the opening of the ureter or farther along in the tube should be carefully determined by the finger and probe. The removal of a stone from the opening of the ureter requires skill and patience to secure the best outcome. The parts should be thoroughly cleansed after removal of the stone, especially if purulent processes have been present. In the absence of infective kidney changes the incisions of the kidney can be closed with fine catgut and the abdominal wound closed completely in the usual manner; in their presence, however, closure of the kidney wounds should be omitted. Where infection exists, the introduction of a rubber drainage tube *behind* the kidney, the

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sequent removal of the bone when necessary. When either examination of
the ureter or of the lower part of the kidney, or possibly the control of deep
hæmorrhage, is demanded, the incision is extended farther downward in a
curved manner toward Poupart's ligament, then inward, parallel to and an
inch above it as circumstances suggest (a, b). The bleeding points are
caught and tied as the incision is deepened. Approach carefully and divide
at first a limited portion of the transversalis fascia cautiously, avoiding the
colon, which frequently bulges into the wound; draw aside the borders of

the wound with broad retractors,
being sure to include the colon;
pass the forefinger behind the
loose covering of the kidney and
press the structures forward;
seize and drag into the wound a
portion of this covering with two
pairs of long forceps, and snip
the tissue between them with
scissors; note the prompt ap-
pearance of the fine yellow fat
which closely invests the kidney;
pass into the opening made by
the scissors first one then the
other index finger; draw aside
and carefully detach the fatty
tissue from the posterior surface
of the kidney with the fingers;
palpate the pelvis and the upper
part of the ureter to detect the
presence of calculi, and prevent
with the finger the entrance, if
possible, of any calculus into the
ureter that might occur as a re-
sult of the further manipulation

Fig. 1214.—A line of approach to the kidney
and ureter, Morris's method. a, d. Primary
incision. a, b, and c, d. Secondary incisions.
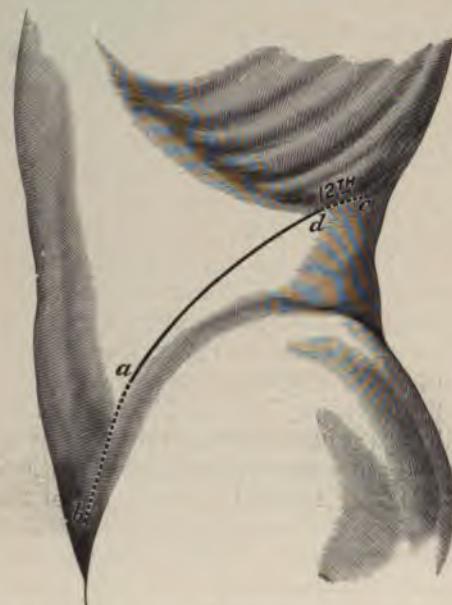
of the organ; free the kidney at all aspects from its fatty environment and
raise it, if practicable, freely out of the wound; seize the organ with the
thumb and finger so as to steady it, and compress the pedicle to control
bleeding while making an incision into the kidney along the convex bor-
der; introduce through the incision into the kidney the right index finger,
and examine carefully the interior for stone; remove through the open-
ing by means of forceps any calculi that may be discovered, cautiously
enlarging the opening by stretching or cutting, so as to permit the
escape without needless laceration of the tissue; press upward, if possi-
ble, into the pelvis any stone lodged in the upper end of the ureter, and
remove it through an incision radiating from the hilum down upon any
other calculus that may be present in the sound kidney; make the inci-
sion in pouched and atrophied portions of the kidney, extending from
the primary opening in the direction best intended to facilitate a prompt
and secure removal of either simple, multiple, or branching calculi; explore

pexy (page 1005). After division of the transversalis fascia expose the fatty capsule freely by wide retraction of the borders of the divided tissues; expose the kidney by dividing and pushing aside the fatty capsules; press the kidney into the wound from in front; introduce the finger between the fatty capsule and the kidney at the posterior surface, and feel for the presence of stone while counter pressure is made in front; examine the anterior surface, using firm pressure for the purpose; thrust the exploring needle (Fig. 1197, *a*) into raised or indurated areas of the kidney to determine the presence of stone. If nothing unusual be noted on palpation, the exploring needle may be introduced, although the procedure is regarded by Morris as being absurdly inefficient and should rather be superseded by deliberate incision. The pelvis of the kidney can be readily explored by means of a small sound (Fig. 1197, *p*) passed into it through a narrow incision made into the calyx at the lower end of the organ (Lloyd). The metal *bougie à boule* (Fig. 1733) is the better searcher for this purpose (Clarke). Failing with these means to find a stone, make an incision at the external border of the kidney (Morris and Kelly) (Fig. 1213), or through the wall of the pelvis itself (Thornton), through either of which examination of the pelvis can be made by the finger or an instrument. Incision at the external border is regarded as the best, since the wound bleeds less, heals more promptly, and is less liable to be followed by a fistula. The situation, size, shape, and compactness of the stone will determine the freedom of removal. If a stone be located in the cortical tissue, it should be removed through an opening made directly down upon it. If it be in the pelvis of the kidney or at the mouth of the ureter, it should be removed through the channel that leads to the discovery, if practicable, otherwise through a short incision into the pelvis at the posterior wall, made cautiously with a sharp knife. Limited incision with a narrow tenotome (Fig. 1197, *a*), followed by digital or instrumental dilatation and rupture, affords the safest means of gaining access to a stone. The stretched and ruptured tissue bleeds comparatively little and heals promptly, and the presence of the finger in the opening reduces the amount of hæmorrhage to a minimum. The stone is removed with the finger, aided by scoops, forceps (Fig. 1197, *f*, *h*, *j*), etc. If it be large, hard, or irregular, it should be broken and removed piecemeal, remembering that it is better to spoil a good specimen than to damage a kidney in endeavoring to preserve the specimen. Stones surrounded by suppurating processes are more easily removed than those that are not, and the removal should be attended with antiseptic douching. The presence of stone at the opening of the ureter or farther along in the tube should be carefully determined by the finger and probe. The removal of a stone from the opening of the ureter requires skill and patience to secure the best outcome. The parts should be thoroughly cleansed after removal of the stone, especially if purulent processes have been present. In the absence of infective kidney changes the incisions of the kidney can be closed with fine catgut and the abdominal wound closed completely in the usual manner; in their presence, however, closure of the kidney wounds should be omitted. Where infection exists, the introduction of a rubber drainage tube *behind* the kidney, the

Nephrotomy.—Nephrotomy consists in cutting into the kidney a greater or lesser depth for the removal of calculi, tumors, fluid accumulation, and for the relief or nephralgia, etc.

The Operation.—Place the patient as for nephrolithotomy; make the lumbar incision (Figs. 1204, 1208) as in this operation in the absence of redness and fluctuation. If either be present, make the incision at the site of the most pronounced redness or fluctuation. Expose the kidney and explore suspicious points found at any aspect of the organ with a grooved needle; incise with a knife and remove with the finger or a scoop pus collections, examining carefully for calculi and communicating abscesses; flush the kidney with a hot antiseptic solution; introduce a rubber drainage tube as far as, and sometimes into the kidney, if extensive disease be present; close the external opening around the tube by sewing and fasten the tube in place; wash the wound through the tube frequently with antiseptic fluid and shorten the tube as healing progresses. If the operation be for hydatid or other cysts, hydronephrosis, pyonephrosis, etc., the incision is made at the usual site, and, as the dissection advances, notable thinning of the respective structures is seen to have taken place, the fatty portion particularly being much condensed and thinned, and perhaps adherent in places to the kidney. Especially is this true if much distention has occurred. If a cyst be present, expose the sac, make a small incision into it with a knife or empty it by aspiration; grasp with forceps and draw outward the relaxing borders of the sac and sew them to the deep tissues of the abdominal wound or, if possible, to the cutaneous borders; examine the cyst cavity with the finger for contiguous cysts; introduce a large drainage tube into the wound, close the borders of the incision around it by sewing, and dress the wound as before. Cleanse the wound through the tube occasionally and apply abundant antiseptic dressing.

The Remarks.—If pyonephrosis or hydronephrosis be encountered, due to obstruction of the ureter, the obstruction should be removed if practicable, through an incision made along the convex border of the kidney, searching the pelvis with the finger for calculi and removing them when found. If due to obstruction from stricture, the course of action noted for stricture of the ureter (page 1074) can be practiced, and the wound treated as in the presence of pus from other causes. Failing in the removal of the obstruction by other operative methods, either a permanent fistula must be anticipated or the kidney removed at once. In instances of perinephritic suppuration attended with induration of the fatty capsule and contiguous structures, one often finds it difficult to distinguish the kidney from its diseased environments, and serious doubts often arise regarding the proper course to pursue in such cases. Free incision only, to determine the degree of disease of the organ, will point out the course of action. Also comparatively innocent appearing perirenal tissues may harbor a kidney incapacitated from disease. In both instances the kidney should be exposed and if possible brought into the wound for examination. In some cases, however, the extended adhesions to contiguous structures make this step impossible, and the question then of nephrotomy or nephrectomy without exposure of the organ arises. We are familiar with an in-

stance in which the diaphragm was torn in the efforts to dislodge a kidney thus imprisoned. The patient recovered. The organ should be incised at the thinnest parts (preferably on convex borders), thoroughly cleansed, the septa ruptured, thus enabling one to thoroughly drain it and estimate the extent of the disease with the view to its removal. The extent of the infection will quite likely forbid sewing, but will enjoin thorough and frequent cleansing and effective drainage. In fleshy persons or those with a narrow ileo-costal space or with a thickened and greatly indurated capsule, subperiosteal resection (page 1029) of parts of the lower ribs may be needed to permit of approach and manipulation of the kidney. Hæmorrhage from incision in these cases may be so severe as to resist all ordinary efforts of arrest, requiring for rescue removal of the kidney, which under the difficult conditions may result in the loss of life.

The kidney itself may form part of the walls of a large abscess in the lumbar region. If the kidney be much enlarged, the lumbar incision should be placed farther forward than usual at the outset or carried in that direction afterward. A movable kidney should be held firmly while being opened if pus is present; if cysts only are present, this manœuvre is of less importance. In either instance a movable kidney should be anchored to the borders of the wound, to secure proper retention there during recovery and afterward.

The hæmorrhage attending incisions of the kidney can be controlled by pressure made on the pedicle of the exposed organ. Alternate superficial and deep sutures are admirably adapted to secure closure of the incisions.

Tuberculous collections in a kidney should be scraped away, and perhaps sometimes cut away along with a surrounding portion of the kidney, in a wedge-shaped manner.

The Precautions.—Avoid cutting the sheath of the erector spinæ. Divide the outer border of the quadratus lumborum if it be unusually wide and cause interference with the field of operation. In all diseases of a kidney suggesting removal, become acquainted with the condition of the opposite kidney before making the attempt. If anuria follow operation on one kidney, examine the other to note if the cause be not due to obstruction of the ureter in its course or in the pelvis of the kidney from calculus. In such cases prompt removal should be effected.

If the kidney be mobile, careful action is essential or the peritoneal cavity will be involved. The breaking down of partitions between contiguous cavities in the kidney should be avoided, if possible, as severe bleeding is liable to occur from the vessels in the partitions, especially in tuberculous and suppurative processes. The surface of the kidney should be examined carefully after evacuation of a perinephritic abscess for the presence of small abscesses or other circumscribed disease of the organ. Large drainage tubes and frequent cleansing are required in suppurative kidney changes to secure cleanliness and avoid sepsis. Drainage tubes should be introduced into the kidney with care, as they frequently cause pain.

Ransohoff expresses the following conclusions regarding operation for renal calculus: " 1. An absolute diagnosis of stone can not be made. 2.

Nephrolithotomies may be divided into those of necessity and those of choice. In anuria and profuse hæmaturia delay is fatal. 3. Pyuria and microscopical hæmaturia, as indications of beginning destructive changes, are positive indications for operative exploration. 4. The oblique incision is to be preferred for the ease with which it permits the exploration of the entire kidney. 5. Acupuncture is not to be relied upon. 6. Incision should be made along the convex border and only when the circulation is controlled by digital compression. 7. Incisions into the pelvis for exploration and for removal of a stone are to be avoided. 8. Primary nephrectomy for stone should be reserved for extreme cases. 9. Primary union by suture, where possible, makes nephrolithotomy an ideal operation. 10. Tight packing of the kidney wound and perirenal space endangers the nerve supply of the colon. 11. Nephrorrhaphy should form the closing act of every operation which has seriously disturbed the relations of the kidneys."

The Splitting of the Capsule of the Kidney.—In this procedure the kidney is exposed the same as for nephropexy and the capsule only is incised along the convex border with the idea of lessening the intra-renal pressure or otherwise exercising an effect not yet fully comprehended. This practice has proved beneficial and even curative in instances of severe and otherwise *intractable nephralgia*. The pains of *congestion* of an inflammatory or of an *obstructive* nature, especially in the latter instance when due to *kinking* of the *pedicle* of the kidney from rotation of the organ, are relieved. In these cases nephropexy is both preventive and curative. Renal tension in albuminuria may be relieved by puncturing the capsule in several places (Harrison). The relief following operation in fallacious cases suggested the merit of this practice.

Nephrotresis (Morris).—In nephrotresis (nephrostomy) a urinary fistula is established between the kidney and another part of the human system. Two varieties of this procedure are recognized; the *lumbar* and the *abdominal* or transperitoneal methods of practice.

The Lumbar Method.—In this plan of practice the incision is made the same as for nephrotomy and nephrolithotomy and the kidney is exposed. *If the kidney be not dilated* but perhaps enlarged and congested as from acute interference with the exit of urine from the organ, dependent, for instance, on calculus impaction, the explorative incision should be made along the convex border of the organ, permitting the escape of fluid from the pelvis of the viscus and also the introduction of the finger for explorative purposes. After the arrest of hæmorrhage, if the obstruction can not be removed at this time, sew the cut borders of the kidney to those of the lumbar wound, remembering to attach them to the deep layers if for temporary, and to the integumentary layer, if for permanent apposition. Close the lumbar wound except at the part corresponding to the attachments of the kidney.

If the kidney be dilated, the posterior surface should be opened into the pelvis of the kidney and the partitions between isolated collections of fluid broken through or divided and made to communicate freely with each other; also, it should be determined if the upper ureteral orifice be free by

means of a sound or probe. The borders of the incised kidney are then united, and the wound is treated as in the preceding instance.

The Abdominal Method.—The abdominal method is practiced when the tumor has a free contact with the abdominal wall, enabling one to safely establish a sinus at the point of contact, or when for some reason the lumbar route is not feasible. The incision in the abdominal method is made over the site of the greatest prominence if practicable, preferably through the median or the semilunar line or the fibers of the rectus. If adhesions have already taken place the opening may be made at once; if not, push aside the intestines with gauze, divide for two inches the peritonæum, and raise it off the tumor and sew its borders to those of the parietal peritonæum, thus excluding from the peritoneal cavity the operative field. Incise the tumor, discharge its contents, cleanse the wound, and sew the borders of the renal incision to those of the abdominal. Cleanliness, thorough drainage, and, when practicable, the removal of the obstructing cause should be secured.

The Remarks.—An abdominal operation is objectionable when it interferes with subsequent operative practice in this region; when possible, ureteral anastomosis ought to supersede nephrotresis, thus substituting a lesser for a great affliction. Exceeding care is needful to obviate the decided annoyance that attends urinary fistulæ, also to limit the danger of infection.

The Excision of a Terminal Part of One or More of the Lower Ribs.— For the purpose of greater freedom of manipulation and inspection in connection with operations on especially the kidney, the liver, and spleen this operation is so often practiced as to require at this time that something especially directed to the manner of procedure be stated. Sufficient of the terminal ends of the twelfth, the eleventh, sometimes of the tenth and the ninth ribs, are removed for the purposes stated above.

The Operation.—Make upward from the ileo-costal incision already formed to the rib under attention a vertical incision; reflect upward the flap sufficiently to bring this portion of rib into the field of operation; divide down to the bone in its long axis the superimposed tissues and the periosteum the requisite distance; strip off the periosteum with a strongly curved periosteotome from the exposed portion and resect it with saw or sharp forceps. The procedure is simple, requiring only ordinary caution to prevent involvement of the pleura.

The Results.—In nephrotomy the general death rate is about 20 per cent. In calculus pyelitis the death rate is about 43 per cent; hydronephrosis, 46 per cent; for other causes a much less per cent. Later results show some improvement.

Nephrectomy.—Nephrectomy consists in the removal of the whole or a part of the kidney for cure of tumor, fistulæ, and those conditions not relieved by the preceding kidney operations. *Lumbar* and *abdominal* nephrectomy indicate the routes of entry to the kidney, *complete* and *partial* nephrectomy explain the limit of the removal of kidney substance.

Before attempting the removal of a kidney for disease, the ascertaining of the presence and condition of its fellow is manifestly important. It is estimated that in one in four thousand persons a solitary kidney is present. The knowledge gained by physical examination and the known relation of

certain diseases to the kidneys, combined with catheterization of the ureters, cystoscopy, and the X ray are means of determining the comparative condition of the organs before operation (page 1083). The examination of the kidney through an abdominal incision with the hand is not an uncommon practice. The patient should be thoroughly prepared by therapeutic means and in an aseptic manner for the operation of nephrectomy.

Lumbar Nephrectomy.—The line of incision in this operation is varied, according to the demands of the case and the fancy of the operator. *If the kidney be but slightly enlarged* and not adherent, a single oblique incision, beginning at the outer border of the erector spinæ an inch below the last rib and going forward and downward to the iliac crest, and even curving forward above the crest, if greater room be needed, affords an admirable method

Fig. 1215.—The operation of nephrectomy, kidney lying outside. *a'*. Renal artery. *a*. Subsidiary renal artery. *b*. Renal vein. *c*. Ureter.

of approach (Figs. 1204 and 1214). *If the kidney be of large size* and much adherent, considerable room will be needed for its removal. In this case the oblique primary incision is made first, and supplemented thereafter by either a superior, middle, or inferior transverse incision, according to the demands of the operation as based on the examination of the kidney made through the primary incision. In neither instance, however, is the peritonæum purposely involved in the incision.

The Operation.—Cleanse the field of operation and place the patient (Fig. 1198) so as to expose the wound to a good light; make the oblique incision already mentioned, dividing the tissues successively down to the kidney, if practicable; examine to ascertain the condition of the parts with the hand introduced into the incision; make, if needed, the necessary supplementary transverse incision at the point best intended to facilitate the examination and removal of the organ; draw the borders of the wound

well asunder and arrest hæmorrhage; with care enucleate the kidney from the fatty capsule, if advisable, by means of the finger or a blunt dissector; if not, separate the fatty capsule, together with the kidney, from the surrounding tissues; push the kidney into the wound as far as practicable by abdominal pressure, and define the pedicle; with care isolate the pedicle as much as possible; raise the kidney from its bed and bring it outside the wound (Fig. 1215), if feasible, and cause it to be held steadily, without traction, by an assistant; note the pulsation of the renal artery, and with it as a guide isolate the ureter and vessels from each other; tie firmly *en masse* the vessels with a strong silk ligature carried into position by means of a large aneurism needle or ligature carrier (Fig. 1197); isolate and catch the ureter with forceps; sever the pedicle at a safe distance from the ligature with scissors; cut off the ureter and remove the kidney mass.

The Treatment of the Pedicle.—The vessels may be tied in two or three bundles, or, as remarked, *en masse.* The latter plan is often employed, and by some the results are regarded as better than when the vessels are isolated and tied independently, as secondary hæmorrhage with independent tying appears to be more commonly associated. A ligature applied at either side of the line of the proposed division of the pedicle is serviceable. The application of a strong clamp to the outer limit of the pedicle is highly commendable, especially when a danger of the escape of infecting products from the kidney pelvis may follow the division of the pedicle. In fact, the clamp is often employed in lieu of the ligature, and in the great majority of instances it meets satisfactorily the demands, though an occasional secondary hæmorrhage serves to admonish the surgeon of the dangerous uncertainty attending its use. It is sometimes quite impossible, at first, to form a pedicle at a safe distance from the vena cava, when a long, strong ligature is carried around the base of the growth by means of an aneurism needle and drawn tightly by the fingers or an écraseur and the kidney cut away as close to the ligature as is safe. In some instances it may be necessary to leave behind a small portion of the kidney to insure securer hold of the ligature. Incautious separation of a large growth from the vena cava may cause profuse and often fatal hæmorrhage from cutting or tearing of that vessel. *If the vena cava be torn,* compress the bleeding point instantly with the fingers of one hand and the aorta with those of the other; cause an assistant to compress the vena cava at the upper and lower limits of the field of operation, then remove the direct pressure from the wound of the vena cava, sponge away the blood and find the injured point; unite the divided borders (page 214, vol. i) of the venous wound with a continuous catgut suture (Weir). After the removal of the diseased structures by piecemeal cutting, the pedicle is secured and tied in as deliberate and efficient a manner as possible at a proper distance from the large vessels. No tension should be made on the pedicle during its ligature or division, as the proper relations of its structures would then be disturbed, and, after division is made, their consequent unequal retraction would render the ligature insecure.

The Treatment of the Ureter.—If the ureter be much diseased, it should be thoroughly cleansed, the end surrounded with gauze and brought for-

ward and fixed in the abdominal wound with a safety pin (Thornton), or carried through an opening in the loin (Morris), or it may be isolated as low down as possible, ligatured, the extremity cauterized and returned to the abdominal cavity. If healthy, simple ligature and cauterization of the end will suffice. In the instance of tuberculous kidney the ureter may be involved, and therefore should be removed (page 1067) and not returned to the abdominal cavity unless uninfected. The outer end of the incision should be vertical, thus affording a better chance to observe and treat the pedicle. In solid growths of the kidney the supplementing of the lumbar with the Langenbüch incision (Fig. 1101) obviates the need of a rib resection (Morris). Hernia is a likely sequel of König's incision (Fig. 1204) for obvious reasons, and it should be made with seemly prudence. The presence of disease and strong adhesions, resisting well-directed vigorous efforts and exposing to severe injury the diaphragm, colon, and large vessels, suggests subcapsular removal instead of the usual form of practice. However, since the latter plan is often followed by enduring fistula, it, too, may be a choice of evils.

Morris introduces a double plaited silk ligature between the ureter and the vessels, ligaturing the former at once, unless diseased, after which the vessels are ligatured and severed and the ureter divided as far down as possible, even below the brim of the pelvis, cleansed, and dropped back awaiting removal along with the kidney.

Subcapsular Nephrectomy.—Subcapsular nephrectomy is indicated when the hypertrophied and distorted perirenal tissue is so closely encompassed with the capsule proper of the kidney that the removal (nephrolysis) of the former can not be accomplished without serious involvement of the diaphragm, colon, peritonæum, etc.

The Operation.—Expose the kidney as for pericapsular nephrectomy (page 1030) ; excise the capsule proper along the convex surface the entire length if possible; raise the divided borders of the capsule with forceps and separate the capsule from the parenchyma with the fingers, and when the hilum is reached clamp with long curved forceps the pedicle and cut the kidney away, tying the vessels on the cut surfaces ; or transfix the pedicle with a stout ligature, tying it in halves, leaving ligatures long for traction purposes in the event of hæmorrhage; cut away the kidney, carefully examine the capsule, and remove as much of it as possible.

The Remarks.—If the duct be tied separately, followed by the tying of the vessels, the hæmorrhage that would follow insecure ligature of the transfixed dilated pelvis will be avoided. If the proper capsule can not be separated the kidney should be removed in pieces, tying the portion nearest the hilum. A long convalescence follows this measure; sinus formation of long duration, and perhaps permanent, is a common sequel of the subcapsular removal. If cancer, tubercle, or like disease have invaded the structures, only removal of the entire mass offers a chance for recovery. In the instance where patient dissection may secure removal of the indurated perirenal tissue subcapsular removal should be delayed.

Abdominal Nephrectomy.—The abdominal route is suitable in the instances of large tumors, fat subjects, lateral deformity of the spine, those

cases in which much room for examination and manipulation is required, and those that offer a minimum danger of peritoneal infection, as well as where examination of the other kidney is demanded. The initial incision may be made through the linea alba or the linea semilunaris (Langenbüch). The latter is usually selected, as it leads more directly to the kidney and ureter, and offers less exposure of the peritoneal surface to the exigencies of the operation. The late *Greig Smith* regarded an incision made through the outer fibers of the rectus muscle with especial favor, as then the aponeurotic muscular and fascial tissues remain intact and hernial sequels were prevented.

The Operation.—Make an incision into the abdominal cavity not less than four inches in length in the line already indicated (Fig. 1101), with its center opposite the navel; interpose a large, flat sponge or aseptic gauze wipers to hold aside the intestines and absorb the oozing blood; introduce the hand into the abdomen and examine carefully the condition of the kidney; shut off the peritoneal cavity from the field of operation with sponges or pads; expose the kidney by tearing through the peritonæum where it forms the outer layer of the mesocolon (Fig. 1196, *e*), thus avoiding the nutrient vessels of the colon; separate the front of the kidney from the perirenal fat with the fingers; expose the renal vessels through the opening by drawing inward strongly the inner border of the wound with a wide hooked retractor, aided by outward displacement of the kidney; isolate the vessels with the fingers aided by a blunt dissector, and carry around them with a large aneurism needle a strong silk ligature; tie the ligature firmly, and catch the ureter with forceps; isolate the kidney completely with the fingers and sever the vessels and the ureter at safe distances from their points of constriction; raise the kidney mass from the wound, and insert sponges or gauze to arrest oozing; cleanse the wound of all escaped fluids, and arrest the bleeding points. If drainage be required, the end of the tube is caused to escape through an opening made at the loin. The peritoneal opening in the mesocolon need not be closed unless the external wound be infected, as the parts are promptly pressed into position by the intestines. The abdominal wound is closed and dressed as in other instances.

The ureter should be treated in this, as in the preceding operation. However, entire removal or the carrying of the end out at the loin are the most advisable.

Terrier attaches at once to the divided borders of the posterior peritonæum three or four forcipressure instruments, where they remain during enucleation of the tumor. He either attaches the ureter to the lower angle of the abdominal wound or ligatures and disinfects the upper end and drops it back. He then by means of the forceps already in place, raises forward the borders of the divided peritonæum, and after proper narrowing of the opening by suture, sews the borders to corresponding portions of the parietal peritonæum. The diminution in size of the abdominal wound by sewing, the introduction of drainage tubes and their retention for ten or twelve days, and even longer if for any reason infection of the wound be feared, constitute the distinctive features of this form of practice which

could be regarded with more favor if the ureter and drainage were adjusted as in the preceding method of practice.

The Combined Lumbar and Abdominal Operation.—Where the tumor is of unusual size from any cause, especially when prompt and easy control of the vessels of the pedicle may become an important feature of the technique, as when the ileo-costal space is unduly narrowed, this method has special and commendable features.

The Operation.—Make an incision through the linea semilunaris into the peritoneal cavity; introduce the hand into the peritoneal cavity and determine the characteristics of the tumor and the state of the affected kidney; introduce and spread out within the peritoneal cavity, beneath the parietal wound, a large fine flat sponge or gauze wiper and close the abdominal wound temporarily with two large sutures tied with bow-knots; expose through the usual oblique lumbar incision the outer limits of the tumor and separate with the hand its posterior surface from the fatty capsule; plug the wound with gauze and cover it with aseptic gauze; replace the patient in the dorsal position, open the wound, push aside and pack off the intestines, and through the wound incise the peritonæum at the outer side of the colon.

Separate the divided serous borders, and through the opening complete the enucleation of the tumor with the fingers, cautiously avoiding injury of the enlarged veins often noted at this time, dividing further the peritonæum at the outer side of the colon when required, to better accomplish the purpose; expose, especially in cases of impending rupture of the sac with presumptive hæmorrhage, the artery and vein of the pedicle and tie the former first if practicable, if not tie both at once; include in the ligature the entire pedicle when under this condition thickening or induration prevents isolation and ligature of the vessels; ligature separately the vessels of the pedicle when the circumstances will permit. Enucleation of the tumor may be facilitated by pressing it forward through the lumbar wound. Delivery of the tumor from the abdomen should be cautiously done to prevent rupture of attached vessels or derangement of the ligature of the pedicle. Sever the ureter as far down as possible unless it has been included in the ligature of the pedicle; remove the tumor, cleanse and drain the cavity through the joint, readjust and close the peritoneal and abdominal wounds.

The General Precautions.—Too vigorous or ill-directed manipulation may wound the colon as it lies upon the diseased kidney, therefore the gut should be scrutinized for the presence of such a mishap. The peritonæum covering the tumor may be torn in the efforts to isolate and remove the growth, thereby opening the way to infection of the peritoneal cavity. The separation of an extensive growth from the vena cava has but rarely caused fatal or even profuse hæmorrhage. The nutrient vessels of the colon associated with the inner layer of the mesocolon should not be injured, as gangrene of the gut is liable to result. If the wound has been infected by pus, etc., during the removal of the organ, gauze packing and lumbar drainage should be utilized. A large vein lying in the outer layer of the mesocolon may be severed in going across to the kidney unless care be taken. Some-

time a large vein lies behind the kidney and ureter, that bleeds freely during the separation of the tumor. Also unusual branches of the renal, suprarenal, and ureteral vessels, and of the aorta, as well as those of the connective tissue, require thought and care.

The General Remarks.—Plenty of room, close observation, and careful treatment of the peritonæum and pedicle are cardinal tenets of successful nephrectomy. Enucleation of the kidney from the fatty capsule is often easier to accomplish than separation of the fatty capsule from the contiguous tissues. Scissors curved on the flat are an admirable aid in enucleation of the tumor. The measures for avoiding, and for the treatment of, shock should be at hand. The ileo-costal space should be made as commodious as possible by proper reflexion and well-supported inclination of the body. *König,* to secure freer access to the kidney than the ordinary incision affords, adds to the lower end of the ileo-costal, vertical, or oblique incision, an oblique extension toward the navel going often to the outer border of the rectus abdominis (Figs. 1204 and 1205). The tissues are divided down to the peritonæum, the hand is inserted into the perpendicular cut, and the peritonæum pressed forward. Still further room can be gained by transverse division of the peritonæum, which, however, must be carefully guarded against infection, and closed as promptly as possible. Increased room for manipulation and opportunity for observation are secured by drawing upward the costal cartilages and by resection of the twelfth rib. In the event of the inability to properly control secondary hæmorrhage by ordinary measures, a firm tamponade of antiseptic gauze should be applied and confined in place for four or five days, and the removal should be conducted with extreme care to avoid a recurrent bleeding. *Mikulicz's* tampon (Fig. 1546) answers the purpose admirably; packing for forty-eight hours is quite sufficient to arrest troublesome oozing. When the colon is much raised by a marked growth the posterior layer of the mesocolon usually presents itself in the incision through the linea semilunaris. The cut edges of the peritonæum located above the seat of the kidney should be closely and finally apposed by sewing, especially when infection beneath is present or anticipated.

The After-treatment.—After removal of the kidney, carefully inspect the pedicle and note that all hæmorrhage is securely arrested; examine the peritonæum for rents, and close any that may be found with a continuous suture of catgut; repair the colon, if injured; cleanse the wound; arrest bleeding; introduce a large drainage tube to the bottom of the wound, along with strips of iodoform gauze if infection or oozing be anticipated; close the wound with deep sutures of chromicized catgut and superficial ones of silkworm gut; dress as usual, confining the dressing in place with a binder. Prompt union is quite common in these cases. If suppuration ensue, the usual flushing through the tube is practiced.

The Choice of Operation.—Briefly stated, the lumbar incision, supplemented with one or more of the secondary incisions, is suitable for all cases, except perhaps those in which adiposity or deformity of the patient seriously interferes with the approach, examination, and treatment of the pedicle, and especially with the arrest of hæmorrhage attendant thereon. In all cases the

abdominal incision gives one good command of the treatment of the pedicle and ureter, and of the complicated relations of the tumor to the important structures at the median line of the body, and the opportunity to examine the other kidney. It is rare, indeed, however, that these benefits are commensurate with the evils resulting from exposure and manipulation of the peritonæum and its contents, to say nothing of the possible impairment of the circulation of the colon, the demands of secondary hæmorrhage, and suitable drainage. Expert operators can employ the anterior incisions with far greater safety than can those of ordinary attainment.

The Results.—As might be supposed, the death rate in abdominal nephrectomy exceeds that of the lumbar method, due in part to the presence of more extensive disease and greater danger of peritoneal infection in the latter cases. The general death rate of the abdominal method is from 40 to 50 per cent, of the lumbar from 20 to 30. The general death rate of nephrectomy for suppurative calculous disease is from 30 to 40 per cent.

In a later series of cases, of 200 lumbar nephrectomies collected by *Tuffier*, 28.4 per cent died; 112 of these were done for suppuration, mortality 35.9 per cent; 42 for hydronephrosis and neoplasms, mortality 24.5 per cent; and 46 for tuberculous kidneys, mortality 28.2 per cent. Of 161 cases of transperitoneal nephrectomy, 44.1 per cent died; of these, suppurative cases gave a mortality of 43.2 per cent; hydronephrosis 32.4 per cent, and neoplasms 59 per cent. *Morris* reports 105 lumbar nephrectomies done for all causes, with 17 (16.2 per cent) deaths. In special instances of personal practice rates as low as 7 to 15 per cent are reported, for hydronephrosis, 5.75 per cent.

Partial Nephrectomy.—The removal of only the affected part of a kidney, for cure of injuries and morbid growths, has been practiced successfully on many occasions. Instances are noted of partial nephrectomy for the removal of circumscribed malignant disease, tuberculous collections, small abscesses, cysts, and fistulas, with uneventful recovery and apparently final cure.

The Operation.—Expose the kidney, release it from its fatty surroundings, and raise it out of the wound into full view; examine it carefully by inspection and palpation, to determine the seat, extent, and nature of the diseased process and the scope of the operative remedy; compress the renal artery with the thumb and fingers or compress the contiguous tissue during removal of the diseased part, so as to control hæmorrhage; remove wedge-shaped pieces of the kidney with the base outermost in a way to include the diseased processes, slicing the tissue if need be to secure healthy surfaces; arrest hæmorrhage, appose, and unite with fine silk or catgut the borders of the kidney wound; plan the incision so that cut surfaces may be apposed if possible. Use healthy capsule or approximation sutures so as to cover in cut surfaces when the preceding plan is not attainable; suture the wound of the kidney to the contiguous soft parts and tampon between them if need be, when other measures of repair are not adequate and open granulations of the cut surface are not formed.

The Remarks.—Provide free drainage, especially when the pelvic cavity of the kidney is invaded. Close the superfluous parts of the abdominal

wound with sutures. Patient attention and effective means of cleanliness are required to prevent irritation in case urine escapes from the opening. Circumscribed, isolated, superficial morbid changes may be scraped away and the surface allowed to granulate.

It is proper to note in this connection that *Bradford's* experiments on dogs demonstrate that excision of a portion of the kidney is followed by an aqueous increase in the urine and in direct proportion to the amount of the organ removed, also that the function of the portion of kidney remaining appears to be able to excrete a comparatively increased amount of urea.

The Results.—Morris reports ten cases done for various reasons, all of which recovered from the operation, but one died within three months from pulmonary tuberculosis. *Bloch* reports eleven cases, of which nine recovered. It appears that the operation itself is entirely feasible for other than malignant disease or extensive tuberculosis. In these respects further experience will be required to fix its proper status.

Extraperitoneal Nephrectomy (abdominal incision).—Extraperitoneal removal of the kidney can be practiced in simple cases before or after entrance to the peritoneal cavity. *In the first instance* the abdominal incision is carried down only to the peritonæum, and thereafter the peritonæum is reflected from the abdominal wall around to the kidney, which is then removed in the usual manner. *In the second instance* the incision is made into the peritoneal cavity, the kidney is examined, and, if the conditions warrant its removal, the outer border of the incision through the mesocolon is sewed to the inner border of the incision through the parietal peritonæum, thus constituting substantially a subperitoneal route through which the kidney is released and removed. It is important, however, in this connection to note that valuable time and opportunities may be sacrificed not infrequently in the practice of ingenious though unwise technique.

Renal Decapsulation (Nephrocapsectomy).—Renal decapsulation is a measure brought forward by Edebohls and consists in the removal of the proper capsule of the organ " with a view to the creation of a new and increased blood supply to the diseased kidney." The kidney is exposed as in nephropexy, the fatty capsules are removed; an incision is made through the proper capsule along the convex border from pole to pole of the organ, and the capsule is carefully stripped off, quite back to the pelvis at its various aspects and cut away. The naked organ is then returned to its former site, fixed by sutures to the muscles of the back and the wound closed by buried and integumentary sutures, then dressed, and the patient kept quiet until union is secured; drainage is not employed except in instances of infection. (See *Emerson's* conclusions, page 1016.)

The Remarks.—Edebohls reports " 72 cases operated on between six months and eleven years and a half ago," 69 of which he has followed.* Of 51 patients operated on, 14 died from twelve hours to eight years after operation. Ten cases radically cured; 12 greatly improved.†

Puncture of the Kidney.—Puncture (from without) of the kidney for diagnostic purposes may or may not be a dangerous procedure, depending

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* New York and Philadelphia Medical Journal, May 21, 1904.
† Boston Medical and Surgical Journal, March 12, 1903.

on the care with which it is practiced and the environment of the organ as influenced by the morbid processes connected with it. According to *Morris:* "The point selected for puncturing will depend on circumstances. If there be a spot over the swelling which is thin, soft, prominent, or fluctuating, the trocar can be inserted there. A point which is not seldom indicated is midway between the umbilicus and the anterior superior spine of the ilium, or half an inch below and an inch and a half to the side of the navel. When no particular spot is suggested by the discoloration or prominence, no better place can be selected on the left side than an inch in front of the last intercostal space; but if the tumor be of the right side this is too high, as the liver will probably be traversed. If there is no indication for operating elsewhere, the best spot to select when the kidney is of the right side is half-way between the last rib and the crest of the ilium, between two and two and a half inches behind the anterior superior spine of the ilium.

"In performing the operation the operating trocar should be inserted without any previous incision of the skin. If a larger trocar be used, an incision through the integument and muscles is sometimes made before introducing the instrument. The dangers of the operation are very slight. If, however, the puncture be made too far forward and through non-adherent peritonæum, some of the contents of the cyst might be extravasated into the peritoneal cavity on withdrawing the trocar, an accident which has proved fatal in more than one case. There is also the danger of wounding the intestine, which, as a rule, is in front of the end adherent to the tumor; and if the trocar is long and is thrust too far inward it might penetrate some important blood-vessel causing dangerous if not fatal hæmorrhage. The penetration of the thin edge of the liver with an aspirating needle, though to be avoided, is not an accident likely to be followed by any ill consequence. The instrument should not be introduced too near the ribs for fear of wounding the pleura." Puncture and drainage for hydronephrosis should be abandoned.

Wounds of the Kidney.—The kidney suffers from external violence not infrequently in various degrees of severity. Wounds of the cortical substance only are less dangerous than are those involving the medullary, for in the latter instance the pelvis of the kidney is apt to be involved when hæmorrhage is much more severe and urinary extravasation more common. However, if the vessels are not injured, and the urine is healthy, the outlook is favorable even when considerable extravasation of blood and urine has taken place. If the cortex alone is injured, bloody urine will not appear, and the urine will not go astray. In wounds limited to the pelvis of the kidney hæmorrhage is comparatively small and urinary extravasation quite the reverse. In these cases blood in the urine is in small quantity and seen often only at the outset, while the amount of urine passed is lessened because of its escape through the opening. Hæmaturia occurs in 20 per cent of cases.

The Operative Treatment.—The chief indications of operative treatment in wounds of the kidney are usually directed to the injured organ, and consist in the prompt arrest of hæmorrhage, the early detection and relief of urinary extravasation, and the prevention of infection. When

penetrating violence causes the wound, with involvement of the peritoneal cavity, the concomitant injuries should be sought for and dealt with as already indicated (page 813 *et seq.*), and the kidney itself treated as circumstances seem to require. But in wounds of the kidney due to other varieties of violence, or to penetrating force when unaccompanied with peritoneal invasion, the lumbar incision—preceded probably by aspiration—should be made as in exposure of the kidney for other reasons. The fact that the majority of injuries of the kidney recover without operation should not lead the surgeon to indulge in complacent procrastination until too late to wisely meet the demands of the preceding indications. And in this connection it should be recalled that primary operative practice is productive of better final results than is the secondary. Therefore, when the early symptoms point to the presence of severe or continuous bleeding of decided character, or to urinary extravasation, prompt surgical exposure of the seat of the injury should be made by enlargement of the primary wound or through a fresh incision at

Fig. 1216.—Suture of the kidney, longitudinal wound. *a, c.* End sutures. *b.* Intermediate suture.

the loin. After exposure of the organ and evacuation of the extravasated fluids the extent of the injury can be ascertained. Bleeding points should be sought for and tied, and vigorous oozing controlled by temporary pack-
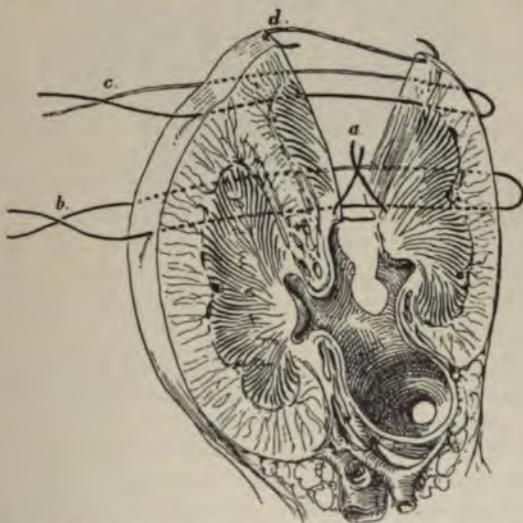
Fig. 1217.—Cross section of the kidney showing incision into pelvis with closure by suturing. *a.* Sutures of fine catgut, placed between calices, including fat and fibrous tissues, but not mucous surfaces. *b.* Deep approximation mattress sutures. *c.* Superficial approximation mattress sutures. *d.* Continuous catgut suture closing capsule.

ing with gauze pending a freer exposure of the field of injury and its thorough cleansing with fluid. Large clots of blood should be removed and the surfaces wiped as dry as possible with gauze. The oozing surface is then exposed and the character of the injury determined. If a clean cut not involving the pelvis be noted, the cut should be closed at once by sewing with interrupted sutures (Fig. 1216). Suturing (chromicized catgut) should
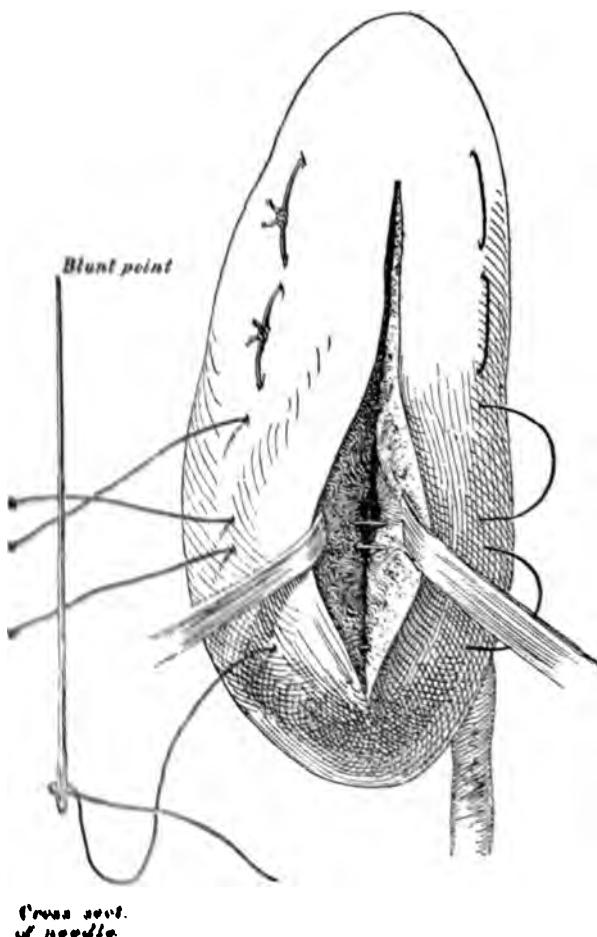
Fig. 1216.—Lateral view of kidney, showing the suturing of longitudinal incision by mattress sutures and a blunt-pointed needle.

commence at either end, approaching the middle of the wound, as the union is completed, using coarse sutures to prevent tearing. If the pelvis is involved and previous infecting disease is present, the pelvic cavity should be thoroughly cleansed, and the wound closed as before, or by through and through sewing (Fig. 1210) with coarse sutures, or partly closed around a drainage tube surrounded with gauze, as circumstances require. If a contused, or lacerated wound not involving the pelvis be present,

and pinching of the pedicle on the injured part does not stop the bleeding, firm packing with gauze may control it and leave also suitable space for drainage. If the wound involves the pelvis of the kidney, thorough cleansing, followed by packing to arrest oozing, may be all that is needful. Extensive disorganization of the kidney or destruction of the vessels calls for total nephrectomy at once. *Kelly* employs three rows of sutures in closing an incised wound of the kidney, placed as indicated in the illustration (Fig. 1217). *Kelly* regards as most valuable the form of suturing of the kidney devised by Hunter and Broedel (Fig. 1218). Stitches thus placed do not tear out because they grasp the vessels transversely in bundles, instead of passing longitudinally between them, thus tearing out easily, as in ordinary suturing. Limited disorganization may be amenable to partial nephrectomy with union by sewing, or packing and drainage only may suffice. If the capsule is intact and the kidney overdistended with fluid, incision into and thorough cleansing of the cavity are indicated. Infected wounds and those in which doubt of prompt and final repair is entertained should be drained. Healthy aseptic wounds should be closed. The present limited knowledge of the scope of operative attacks on the kidney and of the devious characteristics of the injuries, together with the limited space for expression, make it impossible to do more at this time than to present a general outline of treatment.

Fig. 1219.—Suture of the kidney, through and through suture.

The Complications.—Wounds of the large vessels of the kidney are so urgent that they may easily prove fatal at the outset, and if not, prompt and decisive action only will save the patient. Extensive extravasations of blood beneath the peritonæum, extending sometimes to the mesentery, mesocolon, pelvic cavity, etc., are of great significance because of the inability to remove the blood, and principally because of the dangers attending its becoming infected. The pain and vesical tenesmus attending the free entrance of blood into the bladder, supplemented with the liability of infection, demand its prompt removal either by means of a large evacuating catheter or the additional use of a bladder evacuator (Fig. 1265). Failing in these, the squeezing of the organ by the hands passed through a small cœliotomy incision may be practiced (Willard), and even a free incision into the organ itself for the purpose may be necessary. Anuria from injury of one or both kidneys, from shock, from previous disease of the organ, and from injury of a single kidney, also uræmia which may depend on pressure from without due to pseudo-hydronephrosis, should be anticipated, and ample provision made for prevention and cure. The presence of peri-

toneal rupture and peritoneal extravasation of blood or urine should be determined and the dangers promptly obviated by washing and repair. This variety of injury is more liable to happen before ten years of age, as absence of the fatty capsule during this period brings the peritonæum into closer contact with the kidney and therefore renders it less resistant to injury. Severe renal colic dependent on the presence in the ureter of passing blood clots is not infrequent in these cases. A torn or plugged ureter lessens the amount, and modifies the character, of the contents of the bladder, blood not appearing. In the former instance subperitoneal extravasation of blood and urine may require free incision and drainage. Prolapse of the kidney through the wound is a rare complication, and is quite readily met by restoration of the organ to and its fixation in the normal position. The possibility of the occurrence of secondary hæmorrhage should not be ignored, and care in securing the vessels is the most serviceable preventive.

The Remarks.—Usually the injuries are unilateral and both kidneys are healthy, therefore the wounds are non-infected except from without. Hæmorrhage from the cortical substance is less severe than from the medullary, because of the difference in the arrangement of the vessels in the respective structures.

The After-treatment.—Careful cleansing, good drainage, and proper attention to the complications and sequels embody the indications and suggest the manner of treatment.

The Results.—There are not a few conditions, such as a single kidney, diseased kidneys, injury of both kidneys, etc., which almost forbid the entertainment of the idea of a successful issue from any plan of action. The death rate from gunshot wounds is about 80 per cent; from punctured, about 25 per cent; and in rupture, about 33 per cent without and 23 with operative treatment. Primary nephrectomy gives a death rate of about 25 per cent, and secondary of about 39 per cent. The performance of nephrectomy increases the rate of recovery about 8 per cent. By the abdominal route the rate of mortality is 33.3 per cent, by the lumbar about 5 per cent less (Keen). *Otis* collected fourteen cases of punctured wounds without complications of important structures, all of which recovered. Nephrectomy for subperitoneal rupture is attended with a mortality of 27.2 per cent.

Tuffier reports the death rate of uncomplicated cases of rupture at 43, and of complicated at 87 per cent. *Grawitz* reports the mortality rate at 46.3 per cent in this class of cases.

OPERATIONS ON THE URETERS.

The advisability of certain operations on the ureters is accepted, the labors of Van Hook, Fenger, Kelly, and others having established their utility beyond gainsay.

The Anatomical Points.—The ureter is a fibro-muscular tube about one sixth of an inch in diameter, flattened antero-posteriorly, having a wall of about one twenty-fifth of an inch in thickness, nearly half of which is composed of muscular tissue. It is notably elastic, hence amenable to stretching in either axis. It is richly supplied with blood and therefore highly

CYSTOSCOPE.

FIG. 1220.—Instruments employed in operations on the ureter.

a. Scalpels. *b*. Small knife. *c*. Forcipressure. *d*. Straight and curved scissors. *e, i*. Mouse-tooth and thumb forceps. *f, h*. Hollow-jawed and common needle-holders. *j, m*. Large blunt and hooked retractors. *k*. Gum-elastic urethral catheter. *l*. Chromicized catgut. *n, o*. Tenaculum and blunt hook. *p, q*. Long silver probe and metal urethral catheter. *r*. Delicate curved and straight needles. *s*. Catgut and silkworm gut. A waxed-tip catheter, dilating urethral catheters, and hard-rubber urethral bougies are often serviceable. Drainage agents, gauze pads, etc., should be provided.

70

vitalized. It vigorously resists manipulative influences and promptly heals under favorable conditions. The ureter varies in length from ten to thirteen inches. The ureter may be partially or wholly double, and be connected with the kidney above and the bladder below in various abnormal ways. In sixty per cent of subjects it is narrowed at the three following situations: 1, at a point between an inch and a half and two inches and a half from the kidney; 2, at each extremity; 3, at the place where it crosses the iliac artery (Halle and Tanquary). The abdominal portion of the ureter lies on the psoas muscle and is covered by peritonæum, to which it is so closely adherent as to be reflected along with that membrane. The genito-crural nerve is closely associated with it, and therefore not infrequently irritated by the presence of calculi in the tube. The important vascular relations of the ureter are shown by Fig. 179, vol. i.

The course of the ureter from the kidney to the brim of the pelvis corresponds to a line drawn from the junction of the inner with the middle thirds of Poupart's ligament vertically upward. The exact location at the brim is indicated by the intersection of a horizontal line drawn between the anterior superior spines of the ilium and a vertical one passing through the spine of the pubis (Tourneur). At the brim of the pelvis the ureters are about two inches apart. In the pelvis the ureter clings to the pelvic wall, passing outward across the obturator fascia, then curves toward the bladder. In the male it lies close to the free end of the vesicula seminalis, and is crossed at the inner side and above by the vas deferens. In the female it passes beneath the uterine artery in the broad ligament, runs parallel with and half an inch behind the cervix uteri, passes obliquely across the upper third of the vagina, entering the bladder near the middle of the former passage. In the bladder the ureter runs obliquely through the wall toward the median line and opens into the organ three fourths of an inch from its fellow and from the urethral opening. The portion of the ureter below the brim can be palpated through the rectum in the male and through the vagina in the female. Stones are arrested in the ureter most often in the upper part, with about equal frequency at the middle and lower parts.

The ureters serve the active purpose of transmitting the urine from the kidney to the bladder, and the discharge is accomplished in an intermittent manner, occupying from ten to twenty seconds in the passage. The escape of the urine into the bladder is characterized by sudden intermittent expulsions, each lasting two or three seconds. Whether or not the functions of the ureter are carried on in accordance with the established physiological manner and the urine escaping therefrom has the normal characteristics, are matters of great importance in connection with the significance of morbid changes in both kidney and ureter.

The examination to determine the condition of the ureters is of a comprehensive and technical nature. Their vesical openings and the submucous ridges indicating their course through the bladder wall and the urinary peculiarities, can be quite readily observed by means of the cystoscope (page 1375). The portions of the tubes contiguous to the vagina may be exposed and examined as they lie in the connective tissue through an incision made at the antero-lateral wall of the passage, aided by the introduction

into their lower extremities of a bougie. Through an oblique incision (Fig. 1214) and reflection inward of the peritonæum and contiguous organs, the abdominal part of the ureter can be brought into view as it lies beneath the peritonæum closely associated with its own and contiguous vessels. If the bladder and rectum be empty, the lower extremities of the tubes can be palpated by introduction of the finger high up into the latter passage, and although varying somewhat in position, they are quite readily distinguished under normal conditions as freely movable fibrous cords, by direct and bimanual pressure. Direct, deep abdominal palpation made along the semilunar line will often disclose the presence of a diseased ureter, especially at the brim of the pelvis, where the abdominal wall is thin and much relaxed. The introduction of a suitable sized, highly polished silk catheter into the ureter (page 1043) enables one to determine the presence of constriction, of obstruction, and approximately their nature, and perhaps also the condition of the kidney itself. The X ray is of great use in many cases.

Vaginal palpation through the antero-lateral fornix may disclose a diseased ureter, but a normal one is difficult to determine. Abnormally it sometimes resembles a hard cord, rolling readily under the finger, or it may be irregular, fixed, and painful. The ureter may be mistaken for a band of tissue. Counterpressure on the abdomen facilitates the differentiation, since the ureter does not recede on removal of pressure.

Rectal palpation directed to the outer lateral wall of the bowel at a point a little above the base of the seminal vesicles will enable one to note the ureter, especially if it contain a foreign body or be much diseased. An enlarged prostate obscures it altogether. A normal ureter is unlikely to be detected.

Vesical palpation, in the female, through a dilated urethra, enables one to judge of the state of the kidney from the condition of the orifice of the tube, thus possibly deciding the case to be one of operative endeavor.

Wounds of the Ureter.—Wounds of the ureter commonly arise from external force and from operative violence. The former kind are exceedingly rare because of the small size, firm structure, and isolated and well-protected state of the tube. Those classed with operative violence include the damage to the ureter incident to the loss of substance from removal of structural changes in and contiguous to it. The ureter, although rarely injured by external violence, sometimes suffers in contused, punctured, and gun-shot wounds of the abdomen. How often stretching or crushing force causes the rupture can not be said, but at all events the injury happens more frequently above than below the brim of the pelvis, because the tube may be crushed against the transverse process of the first lumbar vertebra. The difficulty of framing a timely diagnosis in these cases often makes early cure impossible. The infiltration and infection attending a late diagnosis renders at the best the detection and repair of the rupture both difficult and uncertain. *Puncture, incision, and drainage* through the lumbar region or the abdomen in front are the primary measures employed.

Puncture of the retroperitoneal collection of fluids through the loin, although sometimes followed by cure, can not be regarded as a satisfactory method of practice.

Lumbar Incision. A free incision in the ilio-costal space secures prompt escape of extravasated fluids, provides good drainage, and affords opportunity for the exploration essential to determine the seat and extent of the injury, especially if the opening be extended along the iliac crest. However, it is rare indeed that the opening in the ureter will be found unless catheterism of the tube from below is practiced. If the opening is discovered it should be closed by sewing, if possible; but, if it can not be found, or the sewing fails to effect repair, proper drainage should be established pending further procedures based on the presence and condition of the other kidney and the results of Nature's efforts at relief. If the ureter is entirely severed, union of the divided ends by the accepted methods of practice or suitable transplantation of the proximal end (page 1050) should be carried into effect. Failing in the wisest of these means, a permanent urinary fistula in the loin is the obvious outcome. In the event of failure of other means these fistulæ can be remedied by removal of the kidney, provided the other kidney be present and healthy, and the annoyance from the discharge becomes considerable.

Its Recovery. In searching for the ureter the fact that it is carried forward with the reflected peritoneum, and that its line of attachment to this membrane is scarcely more than half an inch external to its connection with the spinal column, should be kept in view. The frequent prompt healing of injuries to the ureter made by the surgeon should emphasize the necessity of arranging the tissues in the instances of undetected injuries in a manner best suited to secure speedy repair. A careful cystoscopic examination to determine the presence and condition of the flow kidney should be made before radical measures are undertaken.

Primary disposition of wounds of the ureter are made according to the nature of the wound. In penetrating wounds, extraperitoneal approach ... in ... wounds, direct approach ... But in such wound ... than good fortune will lead to ... particularly in the presence of ... *longitudinal,* ... closed by Lembert suture ... fortified by infolding of the tissues ... If the wound be transverse and ... of the transverse wound toward ... cutting off of the loin corner there is ... the union of the borders on the ... the ureter open at all ... suggests that the operative wound ... But if the wound open ... covering it with a fold of ... it might ... ends after the manner ... complete transverse wound ... anastomosis (page 1051).

Primary nephrectomy for relief from wounds of the ureter should not be entertained. Other things permitting, *secondary nephrectomy* should be practiced in the involvement of the upper end of the ureter when annoyance from incurable fistula and from the pathologic processes at the seat of the injury becomes burdensome to the physical and mental welfare of the patient. In injury of the lower end, nephrectomy should not be done until after the possibility of uretero-vesical anastomosis and other forms of repair are dismissed.

Operative violence incident to the treatment of surgical conditions associated with the ureter often causes wounds of the tube, which are usually either longitudinal or transverse. The treatment of the longitudinal wounds is considered in connection with calculi of the ureter (page 1065). The transverse wounds, especially when complete, are more difficult of treatment than the longitudinal, on account of the gaping and the tendency to stenosis. In complete transverse wounds of the ureter the divided extremities should be united together (uretero-ureteral anastomosis), unless a loss of substance of the tube forbids. A two-inch gap may be thus closed.

Uretero-Ureteral Anastomosis.—Four methods of this variety of repair are considered:

1. *The transverse end-to-end union with and without support.*

Tuffier's Method.—In this method the ends are directly united together with interrupted silk sutures while being supported by a catheter or other
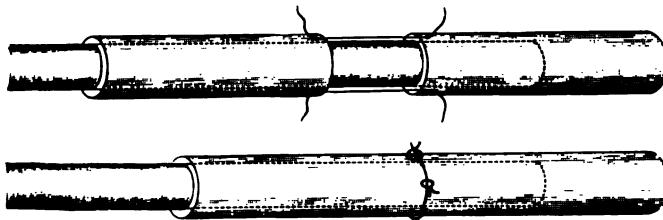
FIG. 1221.—Uretero-ureteral anastomosis, transverse end-to-end, with support. Tuffier's method.

suitable agent introduced into the lumen (Fig. 1221). Afterward the catheter is withdrawn through a slit made preferably in the distal end of the ureter opposite the extremity of the instrument.

Schopf, Cushing, and others united the ends by sewing without the aid of support (Fig. 1222).

FIG. 1222.—Uretero-ureteral anastomosis, transverse end-to-end, without support. Schopf, Cushing, and others.

2. *The oblique end-to-end union* (Borée) (Fig. 1223).

Borée, with the view of preventing obstruction at the seat of union from subsequent contraction, divided the ends obliquely, then dilated them for an inch, and united them together by means of alternating rectangular and

interrupted sutures of No. 1 silk carried by a round straight needle down to, but not through the mucous membrane. The line of union was made additionally secure by four or five interrupted sutures supplemented by perito-

FIG. 1223.—Uretero-ureteral anastomosis, oblique end-to-end union. Bovée's method.

neal investment at the seat of the operation, so adjusted as to exclude from the peritoneal cavity the seat of injury.

3. *Invagination, with and without support, also with and without splitting the ends.*

Markoe, in 1897, in a female patient invaginated and united over a catheter the ends of a ureter divided transversely at a point about an inch from the bladder. A No. 9 woven catheter was introduced into the distal end of the proximal part of the ureter, the free extremity of the instrument being carried outside of the wound. "After careful isolation of the field with sterile pads, two traction sutures were introduced close to the severed end of the kidney portion. The needles attached to these threads were then passed within the lumen of the kidney stump and made to emerge at two points about one sixteenth of an inch apart on the respective sites (Fig. 1224). The free end of the catheter occupying the renal stump was then
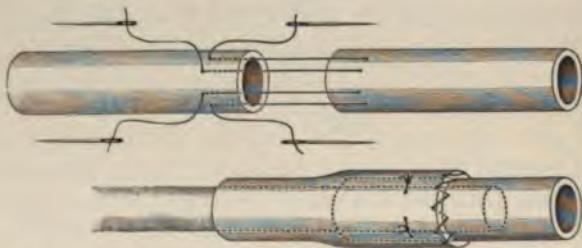
FIG. 1224.—Uretero-ureteral anastomosis, end-to-end invagination, with support, and without splitting. Markoe's method.

passed into the bladder, caught by a forceps introduced into the meatus and drawn down so that its mouth emerged into the vagina. The traction sutures were then slowly tightened, and in this manner the proximal extremity invaginated for about half an inch into the lumen of the distal portion. After tying the traction sutures a circular continuous suture completed the anastomosis." The line of union was further repaired by peritonæum, the wound closed except at the lower part, through which a gauze drain, arising from the seat of the operation, escaped. The catheter, which was allowed to remain in place for five days, when removed was perfectly smooth,

having only a few crystals attached at the vesical end. For several days a
" serous discharge," apparently mixed with urine, escaped. At the end
of a month the patient was substantially well.
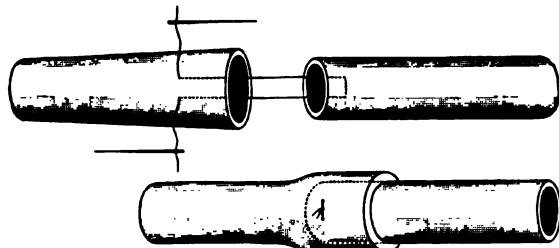
FIG. 1225.—Uretero-ureteral anastomosis, end-to-end invagination, without support
and without splitting. Poggi's method.

Poggi practiced invagination by first dilating the distal end and then
drawing the proximal extremity into it by means of one or more traction
sutures (Fig. 1225), which were then tied.

Robson and *Winslow* attained their aim by first slitting up for a short
distance the open end of the distal part of the ureter, causing invagination
and union of the proximal end by traction sutures (Fig. 1226) the same as
in the preceding method. The slit at the side was closed over the invagi-
nated extremity with sutures. In neither of the last two instances was inter-
nal support employed, and in both additional security is given by sewing the
free ends of the outer to the contiguous walls of the invaginated portion.

4. *Lateral Implantation* (Van Hook).—The method by lateral implan-
tation, as announced by Van Hook in 1893, is practiced as follows: Ligature
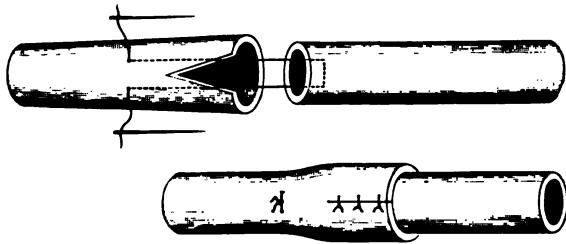
FIG. 1226.—Uretero-ureteral anastomosis, end-to-end invagination, without support
and with splitting. Robson-Winslow method.

the distal portion of the ureter at a point an eighth or a quarter of an inch
from the end with silk or catgut; beginning a quarter of an inch below the
ligature, make an incision into the lumen twice as long as the diameter of
the ureter with a fine, sharp-pointed scissors; make an incision from the
open end of the proximal part upward a quarter of an inch (Fig. 1227, *a*);
pass from without inward through the wall of the upper segment of the
ureter's ureter, an eighth of an inch from the end, two very small cambric
needles introduced an eighth or sixteenth of an inch apart and armed with
a single suture of catgut; carry the needles through the slit into the lower

tube for half an inch, thence out through the wall side by side (Fig.
1227, *b*); remove the needles and then make traction on the extremities

Fig. 1227.—Uretero-ureteral anastomosis, end-in-side implantation. Van Hook's method.

of the suture, thus drawing the upper end of the ureter snugly into the
lower portion, and tie the suture securely (Fig. 1227, *c, d*), re-enforce the
line of anastomosis with a single row of sutures and surround the seat of
operation carefully with peritonæum if the wound be intraperitoneal.
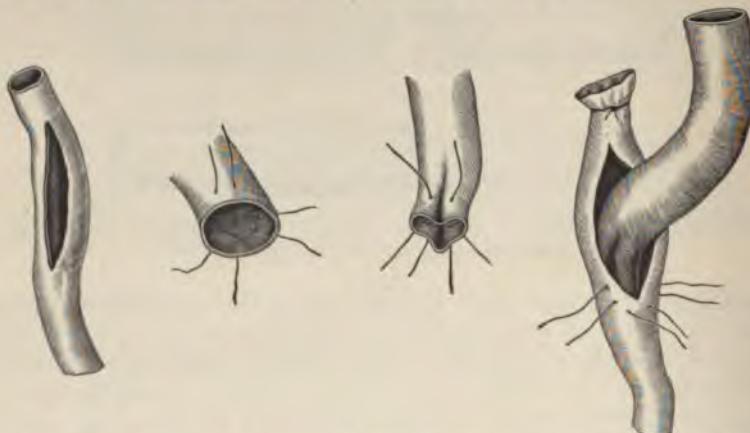
Fig. 1228.—Uretero-ureteral anastomosis, end-in-side implantation. Emmet's method.

Emmet's Modification.—In certain instances the proximal end of the
tube is permanently stretched from the overdistention incident to accumu-

lation of fluids dependent on tumor pressure, calculi, etc. In these cases ready implantation requires that the end be diminished in size, often to a considerable degree.   Emmet attained the object by means of three short sutures introduced at different aspects of the dilated end. The manner of the introduction and of the accom-
plishment of the purpose is suffi-
ciently well indicated by the illustra-
tions (Figs. 1228 and 1229).

Kelly and *Bloodgood* modified somewhat the manner of the intro-
duction of the traction sutures, and added secondary sutures to the line of union. Two needles, each armed with a black silk suture, were intro-
duced through the longitudinal inci-
sion into the lumen and carried thence outward respectively one through each lateral wall (Fig. 1230). As each suture had already been passed respectively through the outer wall of the proximal end, trac-
tion made upon them caused this extremity to enter the lower through the longitudinal slit, where it was fixed by tying the sutures. "Two ad-

Fig. 1229.—Uretero-ureteral anastomosis. Emmet's method completed.

ditional sutures were passed through the lateral walls where the ends over-
lapped," thus completing the anastomosis. *Kelly* practiced the plan suc-
cessfully on the human subject, and *Bloodgood* demonstrated it later on the dog. On the removal of the ureter from the dog at the end of three months,
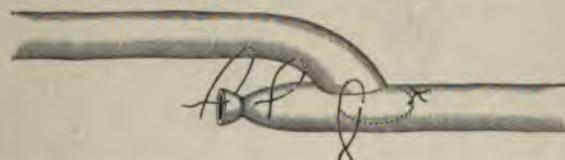
Fig. 1230.—Uretero-ureteral anastomosis, end-in-side.   Kelly and Bloodgood's method.

Fig. 1231.—Uretero-ureteral anastomosis.   Result in Kelly and Bloodgood's method.

an interesting outcome was ascertained (Fig. 1231). The mucous mem-
brane was continuous and no stricture was present.

The Results.—First class: 12 operations with 2 deaths, neither of which was dependent on the ureteral procedure. Second class: 1 operation, en-

tirely successful. Third class: 9 operations with 1 death. Fourth class: 5 operations with 1 death (Bovée).

Latero-lateral Anastomosis (Monari).—Latero-lateral anastomosis is proposed and is executed quite the same as in the intestine (Fig. 1232).
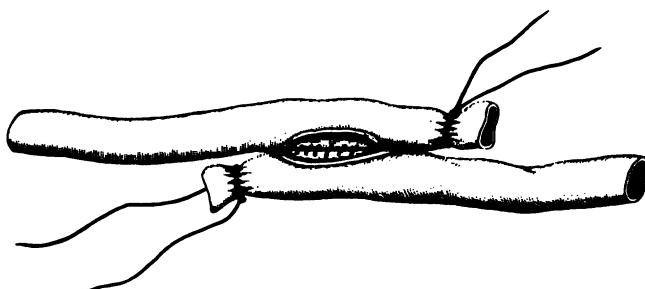
Fig. 1232.—Monari's method of lateral anastomosis of the ureter.

D'Urso and Fabii introduce into the ends of the divided tube for about two inches bougies of proper size upon which the lateral cuts are made, the bougies serving as handles to facilitate the sewing (Fig. 1233). The open ends are tied. There is no good reason to regard this method as having
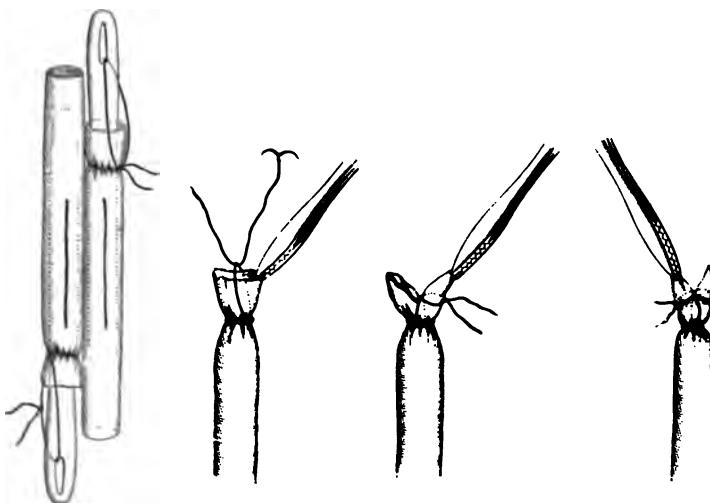
Fig. 1233.—D'Urso and Fabii's improvement on preceding method of practice.

any advantages over the others, and it certainly is less expeditious than some of them.

Kelly has devised an ureteral guide * for facilitating the sewing of the divided ends of the ureter. The ends are first joined snugly with a mattress suture. An incision in the long axis of the proximal end is made near to the point of severance, through which the guide is passed and caused

* Journal American Medical Association, October 6, 1900.

to enter the open end of the distal part of the tube, thus holding the ends in place during the sewing, which is facilitated by means of the handle connected with the guide.

The Choice of Operation.—As yet one can not judge consistently of the comparative value of the various methods because of limited experience. However, the best operation is the one that is most available and least liable to troublesome sequels. The transverse end-to-end methods appear to be more liable to leakage and stricture than do the others. The end-in-end plans, while less liable to leakage and stricture than the former, do not seem to be as exempt from these infirmities as the method of *Van Hook*, and its modifications. In instances of complete division with much dilatation, *Bovée's* method, although somewhat tedious and exacting in its technique, and apparently more prone to leakage than are the invagination methods, nevertheless is commendable and should be comparatively free from stricture sequels. In the presence of complete division with limited dilatation, and also of a normal ureter, *Van Hook's* method is simple, expeditious, and effective. The employment of internal support in the technique, while affording temporary aid, complicates the procedure to a degree not justified by the comparative results of methods. About an inch of the ureter is required for end-in-end (invagination) anastomosis, and an inch and a half for end-in-end union.

Implantation of the Ureter. —When loss of substance has attended division of the ureter rendering approximation and union of the ends impossible, implantation of the proximal part into the bladder, the large intestine, the ureter, or upon the skin becomes necessary. The cæcal, sigmoid, rectal, etc., are the subdivisions of implantation

FIG. 1234.—The implantation of the ureter into the bladder, Kelly's method. *a.* Ureter drawn through opening in bladder by forceps passed through urethra. *b.* One suture introduced holding urethra in place. *c.* Ureter secured in place by deep and superficial sutures.

into the large intestine. The implantation of one into the opposite ureter is an available plan of practice. The grafting into the pelvis of one kidney of the ureter of the opposite kidney may prove serviceable in some instances. The connection of the ureter with the vagina or urethra can

tube for half an inch, thence out through the wall side by side (Fig. 1227, *b*); remove the needles and then make traction on the extremities

FIG. 1227.—Uretero-ureteral anastomosis, end-in-side implantation. Van Hook's method.

of the suture, thus drawing the upper end of the ureter snugly into the lower portion, and tie the suture securely (Fig. 1227, *c*, *d*), re-enforce the line of anastomosis with a single row of sutures and surround the seat of operation carefully with peritonæum if the wound be intraperitoneal.
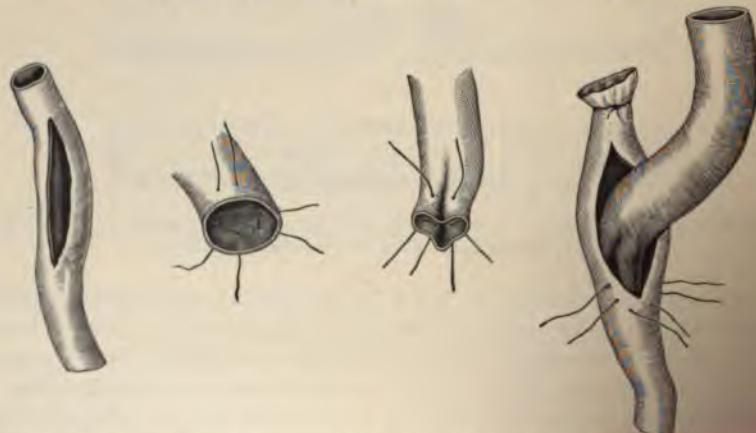
FIG. 1228.—Uretero-ureteral anastomosis, end-in-side implantation.

Emmet's Modification.—In certain instances the tube is permanently stretched from the overdistenti

Veit,[*] because of a lateral operative injury of the ureter, carried the lower part of the upper portion of the tube outside the peritonæum, extended the abdominal incision down to the pubes, opened the bladder outside the peritonæum on the anterior surface, cut the ureter obliquely and united it to the bladder with a satisfactory recovery.

The Remarks.—The carrying of the ureter across the pelvis is objectionable because of the dangers to the kidney and intestines from obstructions due to the distorting effects of adhesions between them.

Through the lumbo-ilio-inguinal incision, practiced by Morris (Fig. 1214) for inspection and removal of the ureter, *Büllinger* proposed extraperitoneal implantation of the ureter into the bladder. *Israel,* through this incision, resected the ureter for stricture located an inch and a quarter above the vesical orifice. The proximal end of the tube was slit up about half an inch, and perfect union of the split end with the mucous membrane of the bladder was made by sewing; the patient made a complete recovery.

Bazy through a hypogastric incision opened the bladder in front, introduced a director into the ureter up to a stricture of the tube; incised the bladder on the director up to the stricture freely enough to permit resection of the strictured portion. Then drew down on the proximal end of the ureter, slit it up about half an inch, and sutured it to the vesical incision.

The Remarks.—This plan is only feasible when the stricture is near to the bladder, and it is regarded inferior to the vaginal and transperitoneal methods.

Amour, through an opening for suprapubic cystotomy, finding a tumor at the ureteral orifice, involving also the end of the tube, stripped the peritonæum of the bladder posteriorly, removed the diseased portions of the bladder and ureter, closed the wound of the bladder, and implanted the ureter into the bladder above the wound.

Colzi, for cure of an abnormal ureteral opening at the inferior part of the vagina, made a crescent-shaped incision at either side of the opening, uniting above at the arch of the pubis. By the aid of oblique incisions, the soft parts were divided and separated from the pubic bones; the urethra and vagina detached and pushed downward, the pre-vesical space entered, and the bladder exposed at the left side down to the usual point of entrance of the ureter. A sound was introduced into the ureter, the ureter separated from the vagina and divided transversely, and the bladder opened by an incision of the external surface an inch long and of the internal mucous membrane about half an inch. The mucous membrane of the ureter was sutured to that of the bladder and the bladder wall united around the ureter by Lembert sutures. The upper end of the lower portion of the ureter was ligatured, closed, and cauterized, and the wound dressed.

The Intra-peritoneal Method.—In this method the ureter is raised from its bed, made free in the peritoneal cavity and implanted into the bladder. Objections to the plan are briefly stated under *Veit's* method.

Krause's Method.—Through an abdominal incision Krause liberated the lower two inches of the ureter and slit up the lower end to increase the width of attachment. At the anterior and at the posterior surface of the

[*] Berlin Klinik, February 27, 1899.

ureter, about half an inch above the incision, a long silk ligature was passed. Through the urethra a long pair of dressing forceps were passed back against the posterior wall of the bladder at a point corresponding to the proper seat of implantation, and an incision was made into the bladder upon the point of the forceps from without; the extremity of the instrument was pushed through the opening, the end of the ligatures grasped by the forceps, the forceps withdrawn, and the ligatures left protruding from the urethra. The ureter was sewed to the bladder and the abdomen closed.

Kelly, finding the ureter too short for proper implantation, liberated the bladder from the rami of the pubis, thus permitting the organ to be displaced backward sufficiently to allow of implantation without undue traction on the ureter. *Witzel* sutured the bladder to the iliac fossa for the same purpose. *Boldt*, for cure of a uretero-vaginal fistula, first passed a gum-elastic catheter through the fistulous opening into the ureter, opened the abdomen, and placed the patient with the pelvis elevated. Although the ureter was fixed because of adhesions, the presence of the catheter permitted of ready resection at a point about three inches above the vagina, retaining in place the adherent peritonæum for the purposes of repair and nutrition. The fragment of ureter was seized at the vaginal junction, the catheter remaining in place, the bladder was partially filled with sterilized water, and then opened as nearly as possible at the normal site of the ureteral orifice, by a third-of-an-inch incision. The water was removed from the bladder before division of the mucous membrane, and a long pair of uterine forceps were introduced through the urethra into the bladder, thence out through the opening, grasping the end of the catheter and withdrawing it by way of the bladder out of the urethra for four inches. The ureter was drawn into the bladder, supported by the catheter, about a quarter of an inch, and fastened in place by means of three fine silk sutures passed externally superficially through the ureter and down to the mucosa of the bladder. The abdomen was closed without drainage, and the patient made a prompt and uneventful recovery.

The Remarks.—The distention of the bladder by water affords a better opportunity to properly locate the points of implantation. The catheter affords easier and better handling of the parts. It should be retained about forty-eight hours until the line of implantation is secure.

Tuffier, for cure of a uretero-vaginal fistula, placed the patient in Trendelenburg's position and opened the abdomen in the median line and incised the peritonæum over the ureter where it crosses the iliac vessels. He raised up the ureter, detached it down to the vagina, and severed it there. The bladder was then opened at the proper site for about half an inch. A catheter (No. 12) was introduced into the ureter, the end of the instrument passed through the opening into the bladder and out through the urethra, taking with it into the opening in the bladder the end of the ureter a sufficient distance to meet the requirements of implantation, which was done by fine silk sutures, five of which joined the mucous borders and the remainder a row which united together the respective musculo-fibrous structures of the ureter and bladder. A good recovery followed.

Baldy implanted the divided distal end of a ureter into the bladder in

the following manner: A double catgut ligature was passed through the ureter at either surface an eighth of an inch from the end. The bladder was incised for an inch at a point best suited to unite it with the ureter, and the sutures armed with curved needles were introduced an eighth of an inch from the incision, from within outward through the bladder wall and tied upon the peritoneal surface, thus carrying the end of the ureter through an extremity of the incision into the bladder. The remaining borders of the mucous membrane of the bladder were united together with a continuous catgut suture, and the wound of the bladder completely closed by separate suture of the deep and peritoneal tissues. By means of two strong catgut sutures the bladder was then fixed to the pelvic walls to prevent undue traction on the implanted ureter.

The Remarks.—The walls of the ureter and bladder were carefully and closely joined with each other by sutures, and the peritonæum was so arranged as to cover all denuded parts. The end of the ureter projected beyond the mucous membrane of the bladder after union, as later disclosed by cystoscopic examination. The wound was drained, the patient making a good recovery. Other similar cases have proven equally successful.

Boari's button (page 1000) has been successfully employed in several instances, being removed after separation from the bladder by means of the various expedients directed to that purpose in instances of foreign bodies in that organ.

Krug, who divided the ureter during the removal of a fibrous tumor, clamped the divided ends, and completed the operation. He then made an incision into the bladder, treated the end of the ureter as done by *Van Hook* for invagination, introduced it into the bladder incision and sewed it there, being careful not to obstruct the lumen. Several tiers of running sutures were made and the available amount of peritonæum employed " to build a solid wall " around the ureter. A catheter was kept permanently in the bladder for four days, after which catheterization was practiced every four hours. The patient recovered promptly without an untoward symptom, and left the hospital in four weeks.

Penrose removed an inch of the ureter which was involved in a carcinoma of the cervix, ligatured the distal and implanted the proximal end into the bladder by *Van Hook's* method, and closed the abdomen without drainage. The patient made a good recovery.

Kelly quotes a case, happening in the practice of Fullerton, of division of a double ureter during the removal of the uterine appendages. In this instance the vesical ends were ligatured and the others introduced side by side into an opening made into the bladder at the superior portion and a little to the right, and sutured. This patient made a prompt and uneventful recovery.

Vaginal Cysto-ureterotresis.—The changing of a fistulous orifice from the vagina through the vesico-vaginal septum into the bladder comprehends so great a variety of operative measures, which for apparent reasons are much more fully treated in exclusive gynæcological works than in one of this character, that the reader is respectfully referred to the former for information.

Operation by the sacral route for repair of a ureter can not be commended except perhaps' when the primary injury requiring the operation was received during a sacral operation for another reason.

The manner of implantation is a matter of great significance. The procuring of secure union, the prevention of constriction and of regurgitation from the bladder are important desiderata. The employment of aseptic care and the prevention of traction at the seat of grafting meet the first requirement. The raising of the bladder higher in the pelvis, and fastening it in place by suturing to the broad ligament or to other convenient structures, is a well-directed effort for the prevention of traction. Traction sutures, attached to the intravesical end of the ureter and passed out through the urethra and fastened to the dressings or held by weighting, are employed with success to neutralize the influence of the upward traction on the implanted end of the tube. The encroachment on the line of repair of drainage agents is objectionable, and should not be permitted when possible to avoid it. Drainage should not be employed in any instance, unless it is deemed as very essential. The splitting of the implanted end of the ureter, and the oblique introduction of the same through the bladder wall, are employed to prevent constriction and return flow respectively. The implantation together of the ends of the ureters and the intimate bladder wall into the bowel is a matter of brilliant conception and successful attainment (page 1365). Implantation may be accomplished quite readily, in some instances, by bringing the end of the ureter and the portion of the bladder into which grafting is to be made outside of the abdominal cavity.

The Remarks.—The abdominal route is preferable in all instances of cysto-ureterotresis, and especially in operative injuries of the ureter, as then the repair can be made before closure of the abdominal incision. Extraperitoneal is preferable to intraperitoneal implantation. However, in the latter plan the peritonæum is closed around the wound so carefully as to constitute in effect extraperitoneal implantation, so far as the wound is concerned. If the peritonæum be drawn too closely around the ureter at the site of implantation, constriction of the tube may follow (Martin). Ureteral fistulæ of congenital or acquired nature are sometimes treated by implantation made through the vagina, which affords a difficult and constricted field of action. Whenever diseased products are associated with the operation field, the intraperitoneal method should, if possible, be avoided.

The Results.—*Bovée* reports 37 ureterocystostomies for injury, 15 by the intraperitoneal and 2 by the extraperitoneal methods, the remainder not stated. In 12 of the former cases resection of the bladder was done. The mortality was a little over 2 per cent. Also 42 ureterocystostomies for various kinds of fistulæ, etc., are reported. Of these, 12 were intraperitoneal, 14 extraperitoneal, and 16 unstated. Four died, of which 2 succumbed to kidney complications at a later period.

The Implantation into the Bowel.—The technical difficulties of bowel implantation of the ureter are much less serious than the resultant infection of the kidney, which appears so likely to follow from the wanderings of the intestinal microbes. Experimentally the technique is successful, but practically the outcome was so frequently fatal in animals as to discourage for a

while the attempt in man. Axial implantation of the ureter into the bowel, and its retention there by sutures; implantation of both ureters with a small associated piece of bladder wall (page 1365); and implantation of the ureters with associated mucous membrane, are the methods of practice commonly employed.

Chaput regards the ascending and descending colon as the parts of election, and operates as follows: Begin the abdominal incision just below the costal border at a point about three inches outside the median line and extend it downward to the level of the anterior superior spine of the ilium, thence in a curved manner to within two inches of the median line; expose the posterior parietal peritonæum in the iliac region and open it parallel with the insertion of the mesocolon, four inches; seize the outer edge of
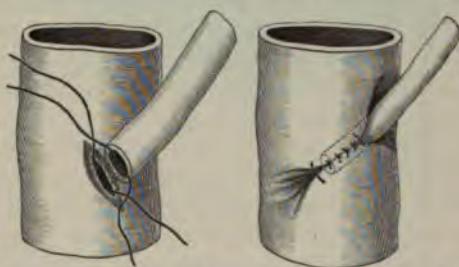
FIG. 1235.—Chaput's method of implantation of ureter into bowel.

the incision with forceps and strip up the peritonæum to the vertebral column; find and divide the ureter between two forceps, tie, disinfect, and replace the lower end, and suture the upper to the posterior and inner aspect of the colon in the following manner: unite the posterior lip of the ureter to the bowel with three or four sutures before incising the latter (Fig. 1235); incise the intestine about a quarter of an inch below the row of sutures in the direction corresponding to the ureteral orifice; suture the mucous membrane of the posterior lip of the ureteral opening to the corresponding membrane of the bowel, also suture the anterior lips in a similar manner as far as practicable; unite with sutures the walls of the
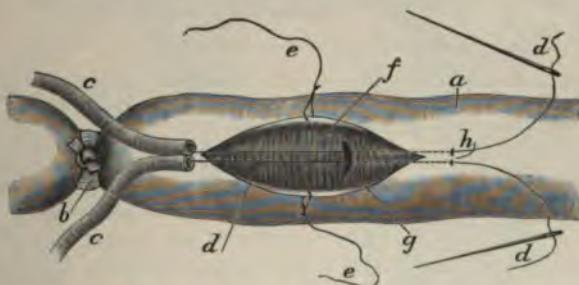
FIG. 1236.—Implantation of the ureters into the bowel, Martin's method. *a.* The rectum. *b.* Point of constriction of the bowel. *c, c.* Ureters joined together in parallel position. *d, d, d.* Silk suture armed with needles attached to the ureters and passing into and out through the wall of the bowel. *e, e.* Traction sutures for drawing apart the borders of the wound. *f.* Muscular fibers of the bowel. *g.* Opening for the passage of sutures. *h.* Points of escape of ends of traction sutures.

bowel; close the remainder of the intestinal incision in the usual manner, burying the ureter in the intestinal wall with two rows of sero-serous sutures, and place a gauze drain over the graft.

71

The patient voided, three or four times *per diem*, mixed urine and fæces, and was satisfied with her condition. No signs of infection of the kidney were present five months after the operation. In another case, a few months later, a fatal result followed.

Martin's Method (Axial Implantation).—The mechanism of this method is substantially as follows: 1. The ureters are caused to so empty into the bowel in its long diameter that the urine and fæces are discharged in the same direction. 2. The longitudinal burying for an inch or more of the ureters in the wall of the rectum permits the pressure of the outgoing fæcal matter on the mucous membrane to empty and compress the lower extremities of the ureters. The muscular contractions of the gut contribute their influence to these results.

The Operation.—Cleanse the bowel thoroughly and place the patient in the Trendelenburg position; expose the rectum through an abdominal incision; incise the peritonæum over the lower three or four inches of the ureters down to the bladder; dissect out the lower three inches of the ureters and tie each with a strong ligature near to the bladder, severing them close above the ligatures (Fig. 1236); bring the renal extremities of the ureters forward and join them together in a parallel position (*c, c*) by passing through their outer walls a long, fine silk suture armed at each end with a cambric needle; make a two-inch longitudinal incision at the uppermost part of the wall of the rectum down upon its muscular coat; expose by dissection an oval surface an inch in width at its greatest transverse diameter, drawing apart the
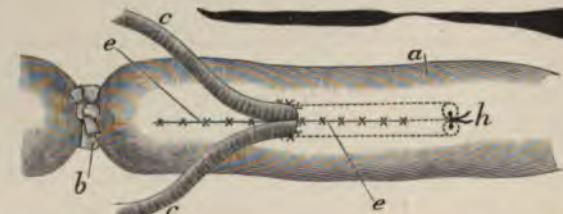
Fig. 1237.—Implantation of the ureters into the bowel, Martin's method. *a.* The rectum. *b.* Point of constriction of the bowel. *c, c.* The ureters. *e, e.* Union of peritoneal borders. *h.* Traction sutures tied.

flaps with traction loops (*e, e*); occlude the bowel above the incision with a clamp or other suitable means (*b*); make an incision into the bowel at a point of the oval space (*f*) three fourths of an inch from the lower end (*g*), large enough to admit the ends of the ureters; pass downward through the opening (*g*) the doubly armed ligature (*d, d, d*), causing the needles to escape anteriorly about an inch below the place of entrance (*h*); draw the ureters through the opening into the bowel as far as the sutures will permit (Fig. 1237). Elevate the ureters (*c, c*) to a right angle with the bowel, uniting them low down to its fibro-muscular coats by fine catgut sutures so passed as not to invade the cavity of the gut or constrict the lumen of the tubes; place the ureters on the denuded surface parallel with the bowel, and unite them at either side to the muscular coats of the intestine; infold the muscular coats by uniting them together with fine silk, thus burying

the extremities of the ureters the distance of an inch; cover in the wound up to the bifurcation of the ureters, uniting the divided peritoneal borders with fine silk (*e, e*); increase the security of the implantation by additional fine silk sutures where needed. The abdominal wound is then closed, leaving sufficient room at the lower angle for the escape of a small gauze drain extending out from the seat of implantation.

The Remarks.—The renal portions of the ureters should be controlled from the outset by pressure to prevent the escape of fluids. This method of practice has been applied both to dogs (thirty-eight) and human subjects (three); to the latter in one instance of removal of the bladder, and in another for exstrophy; the third is not stated.

The Results.—In the case of cystectomy the patient lived three years. In the case of exstrophy the implantation was only a partial success. Of the dogs, 4 lived an "indefinite time," in 2 of which both ureters were implanted in the rectum.

Fig. 1238. Implantation of the ureters into the bowel, Fowler's method. Oblique division of the ureter.

Fowler's Operation.—Fowler aimed to supplement the restraining influence of the circular fibers of the gut on the lumen of the ureter, during defecation, with a valve of mucous membrane so arranged as to provide greater security against ascending infection then and during the presence in the bowel of excrementitious substances.

The Operation.—Thoroughly cleanse the bowel and dilate the anal sphincters; place the patient in the Trendelenburg position and open the

Fig. 1239.—Implantation of the ureters into the bowel, Fowler's method. The tongue-shaped mucous flap.

Fig. 1240.—Implantation of the ureters into the bowel, Fowler's method. The mucous flap attached to the ureters.

abdomen in the median line; draw aside the intestines and identify the ureters and their relations with the vessels; incise the peritonæum; expose and trace the ureters to the bladder wall; sever the ureters on a line with the bladder wall and cut the proximal ends obliquely (Fig. 1238); make a longitudinal incision in the anterior wall of the rectum, through the serous and muscular coats, two and three fourths inches long; dissect carefully aside these tissues, exposing a diamond-shaped submucous space (Fig. 1239); introduce traction loops and draw apart the borders of the wound; cut in the mucous membrane, at the lower half of the field, a tongue-shaped flap with the base upward; double upward the tongue-shaped flap on itself,
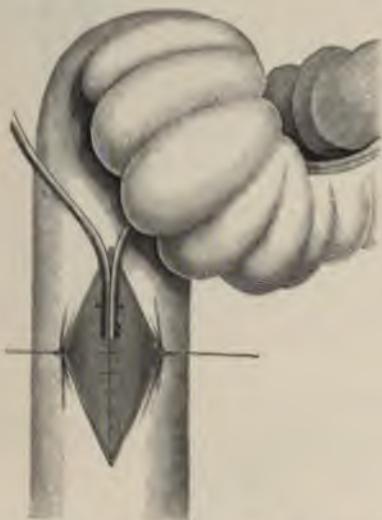
FIG. 1241.—Implantation of the ureters into the bowel, Fowler's method. Gap in mucous membrane closed.

FIG. 1242.—Implantation of the ureter into the bowel, Fowler's method. Sero-muscular coats united.

so that its apex will correspond to its base; join the halves together in this position with a suture at each side, thus forming a flap with a double surface of mucous membrane; place the ureters side by side upon the flap, with their obliquely cut surfaces undermost (Fig. 1240); secure the ureters in position with sutures, being careful that the latter do not invade the lumens of the tubes; push the valve and the attached ends of the ureters into the rectum, and close the rectal wound as follows: close the gap in the membrane left by the reflected flap with catgut sutures (Fig. 1241); close the wound of the sero-muscular coats with silk sutures, causing one or two in their passage to include the wall (not the lumen) of the ureters for better security (Fig. 1242); unite the abdominal wound and place the patient in bed.

Fowler claims the following advantages for this method, which, it seems to us, the history of the case in question justifies: 1. "An efficient permanent valve, with a mucous surface applied to the open mouths of the ureters, is provided. This valve is so situated that it is closely applied to and

occludes the open ends of the ureters as the rectum becomes filled with urine, or when fæcal matter descends."

2. " The placing of the ureters in the submucous space of the rectal wall, for a distance of three or more centimeters (an inch and a quarter or more) above the point where they enter the cavity of the rectum, affords an additional safeguard against renal infection. In this situation the circular muscular fibers of the bowel wall compress the ureters and secure occlusion at this point during defecation."

Krynski exposed the submucous tissue of the rectum, introduced the ends of the ureters into the rectum, and closed the wound, fastening the ureters in place.

Maydl transplants the ureters with an elliptical piece of the trigone of the bladder (page 1365) to the bowel, thus preserving the natural mechanism of the ureteral openings. This method of practice, which certainly is more complicated than either Fowler's or Martin's methods, is commended by the outcome that seems to follow its employment.

Vignoni, Pisani, and many others have devised ingenious plans of action, but it seems to us that those already expressed in detail are better suited to the purpose.

The measures of *Gersuny, Mauclaire,* and *Tizzoni,* directed to division of the bowel, with the idea of establishing an independent delivery of the excretory products, do not require special consideration.

The Results.—Bowel implantation has been performed 65 times on man, with a mortality of 18: 6 died promptly from shock; 7 lived from five days to two years, dying from infection of the kidney or other consequent complications. The causes of death of the remaining 5 are obscure.

The Implantation on the Skin.—Implantation on the skin will quite likely be followed sooner or later by kidney infection. Yet, while this is true, the disease of a kidney may be so extensive as to favor its employment in lieu of the more effective bowel implantation. Implantation on the skin can be made through a buttonhole opening (Pozzi) in the loin (upper end), or at the seat of the abdominal wound. Split the end of the ureter and sew it to the skin. The extension of the ureter through the abdominal cavity provides a bandlike structure that exposes the intestines to the subsequent dangers of entanglement and obstruction.

Splicing the Ureter.—In view of the dangers of infection, and the consequent need of a substitute for skin implantation, as previously considered, *Rydygier* proposed to implant both ends on the abdominal wall and establish a continuity of function by a plastic operation, which consists in turning over them a flap of skin so as to provide for their loss of substance. *Van Hook* proposed the following ingenious plan for splicing a damaged ureter too short to be implanted into the bladder:

The Operation (Van Hook).—Implant the ureter in the abdominal wall in the median line, as near to the bladder as possible, and close the wound except at the point of opening the ureter; open the abdominal wall between the ureter and the pubes down to the peritonæum and bladder, when the patient is recovered from the primary operation; distend the bladder and make parallel incisions at either side of the median line of the

bladder in front, an inch and a quarter apart, downward toward the neck of the bladder for a proper distance to effect repair; unite at the lowest points the two incisions by a transverse one, dissect up and reflect backward the flap, leaving it attached above; separate the ureter from the skin and bring it down, so as to overlap the upturned flap, which latter is then fastened in place with catgut sutures; fasten the ureter in position with fine catgut sutures passed superficially through its walls and the contiguous tissues along its course; sew the borders of the vesical flap together, forming a tube, into the upper end of which the end of the ureter is introduced and fastened in place with sutures; close the bladder wound with catgut sutures, leaving the lower end open for drainage; also close the abdominal wound, leaving it at its lowermost point open for drainage.

The Comments.—Care should be taken not to invade the cavity of the bladder while making the flap. The flap may be lengthened after cutting
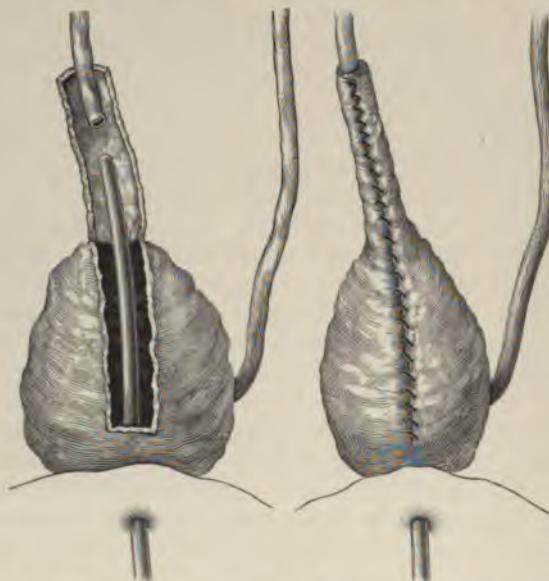
Fɪɢ. 1243.—The Van Hook-Boari operation of transplanting short ureter into bladder.

the peritonæum transversely near its line of attachment to the bladder and sewing it to the bladder as far down as possible, thus affording an extended area for incision.

Boari also figures a similar plan of action, which is amply described by the preceding text (Van Hook) and the illustrations representing the procedure (Fig. 1243).

Bacon suggests ureteral splicing through the agency of an isolated portion of small intestine (Fig. 1244). The loop is isolated and retained in proper place by sutures, and the ends of the ureter split and implanted in the wall of the intestine at opposite points, the lines of implantation being repaired by peritonæum. *Van Hook* suggests imbedding the loop outside

of the peritonæum, making a temporary ureteral fistula above the implanted bowel, the lower ureteral end being brought out below it, and after shrinkage of the bowel takes place, connect it above and below with the ends of the ureter.

The preceding and other ingenious proposals await the verdict of practical employment.

The Remarks.—There is now little need of considering the availability of skin implantation. The improved technique of bowel grafting and the possibility of uretero-ureteral anastomosis, added to the comparatively fatal outcome of the skin implantation, reduces the usefulness of application of the method, mainly to cases of impending nephrectomy, except in single kidneys.

The Results.—*Borée* reports 10 cases of skin implantation. The rate of mortality in those of the number (6) with complete record is about 67 per cent.

FIG. 1244.—The splicing of ureter with intestine.

Implantation into the vagina has been practiced but 3 times, and in each instance with success. There is but little, indeed, to commend the practice, except for some reason the unavailability of other and completer methods.

Uretero-urethral anastomosis (Sonnenberg), or the implantation of a ureter into the urethra, has been performed in 5 instances, in 4 of which the cure of exstrophy of the bladder was the reason for operation.

The anastomosis of the ureter of one side with its fellow, and even possibly with the pelvis of the opposite kidney, is not an impossible accomplishment, although of unestablished utility. *The lowering of a kidney* sufficiently to permit the joining of the ends of a severed ureter may be of service when implantation implies greater danger than does displacement of the kidney.

Ureteral Calculus.—Calculi are commonly arrested at the upper and lower portions of the ureter. The technique of the operation of removal is modified by the situation of the calculus.

At the Lower Portion (Vesical).—Calculi at this situation can be removed through the *bladder, vagina,* or *rectum.* Calculi protruding into the bladder from the ureter, and those near the orifice of the ureter can be removed directly with or without dilatation of the vesical opening, through a suprapubic incision of the bladder and through the urethra directly. When covered with mucous membrane, the membrane is excised and afterward repaired or not by sewing, as seems best.

Removal through the Vagina.—*Emmet* and *Cabot* have each demonstrated the feasibility of this plan of action successfully on the living subject; both patients recovered. In each instance an incision was made through the vagina upon the tumor, the calculus released and removed,

tive point is reached. The field of operation is carefully isolated to prevent infection, the ureter opened longitudinally, and the stone removed.

In a series of five cases, after cleansing the wound, the ureter was closed with fine interrupted sutures in two, and left open in three, instances. Proper drainage was provided in each instance. All of the patients (five) recovered.

Extraperitoneal ureterotomy can be performed after diagnosis of the nature and seat of the obstruction is made through a direct peritoneal incision, which is closed at once. *Transperitoneal ureterotomy* can be performed in those cases that are intrapelvic, and not amenable to approach by another method. Two instances are reported by Fenger in attestation of the worth of the procedure: one died and one recovered.

The Remarks.—Scrupulous care should be exercised to prevent infection, especially in the cases characterized by pus collections at any situation, notably at the pelvic portion of the ureter, and in the presence of exposed serous surfaces. A stone at the upper end of the ureter may be displaced upward into the pelvis of the kidney by manipulation with the fingers or needle pressure, and then removed. However, as Fenger very properly believes, this attainment is not so important if the stone can be directly removed through an extraperitoneal incision.

The Results of removal of stone from the ureter are 3 deaths in 17 cases.

Ureterectomy.—Ureterectomy is performed in tuberculous, cancerous, and suppurative diseases of the ureters. The varieties are the *primary*, where the ureter and kidney are removed simultaneously; and the *secondary*, where the removal of the kidney precedes that of the ureter. In each of the foregoing the ureter may be *partially* or *completely* removed by either the *transperitoneal* or the *extraperitoneal* route. The location and length of the incision for exposure of the diseased structures varies according to the extent of the disease and the route adopted for its removal. In total extraperitoneal nephro-ureterectomy the incision commended by Morris (Fig. 1214) is suitable. In partial operation of this kind the oblique incision, extended if necessary to the outer border of the rectus (Fig. 1204, *c*), is ample. In the transperitoneal operation an incision is made along the outer border of the rectus abdominis of sufficient length (page 1033) to permit of the inspection and removal of the kidney, and it is extended thereafter suitably, to afford ample room for examination and extirpation of the diseased portion of the ureter. In partial or total ureterectomy the incisions of the respective routes of approach (transperitoneal and extraperitoneal) are made in conformity with the demands of the case. In the extraperitoneal operations the peritonæum is exposed by division of the superimposed tissues along the line of incision. The peritonæum is carefully raised from the overlying tissues by means of the fingers, and reflected toward the median line of the body, until the fatty capsule of the kidney or the ureter is exposed. In the first instance the kidney is cautiously enucleated from its fatty environment (page 1032) and removed, the ureter remaining attached. In the second instance the upper end of the fistulous ureter is discovered, clamped and raised, and in both instances the ureter is carefully separated downward from its immediate surroundings to a

distance corresponding to the extent of its disease.   The contents of the lumen are then pushed upward with the thumb and fingers, and a clamp is applied close to the healthy part, around which a ligature is tied, and, after careful isolation with gauze at the latter point, the ureter is divided through the sound portion with scissors, and the diseased structures are removed. The ureteral stump is then cauterized so as to destroy its infected tissue, and dropped back into place.   The wound is wiped with aseptic care, and closed entirely, or the lower end is left open for the escape of a small tempo-rary gauze drain, when its presence is required.   *Kelly* advises that, if the kidney be tuberculous, and the ureter be thus affected in any instance, the latter be removed, if practicable, the entire length.   To properly accom-plish this in the female the ureter is made taut by moderate traction, and its separation is extended to the brim of the pelvis by the fingers, where the
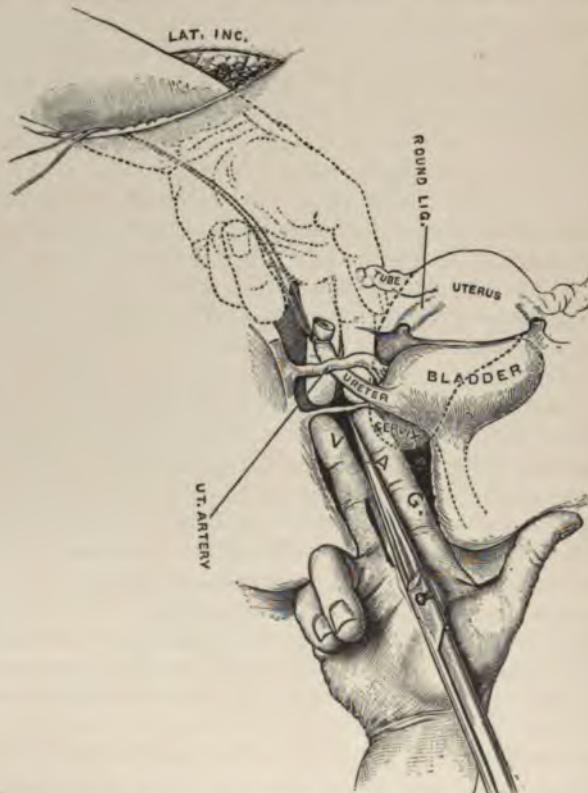
Fig. 1245.—Operation of removing the lower end of the ureter through vaginal vault, Kelly's method. The fingers of the upper hand holding up the uterine artery during perforation of the vaginal vault by the scissors.

iliac artery is felt. The entire hand is then introduced into the wound and passed between the peritonæum and the abdominal wall, thence beneath the peritonæum and the wall of the pelvis, freeing the ureter down to the broad ligament, which is recognized by a sense of resistance and the impression

that it seems to pass into the broad ligament, at which point the pulsation of the uterine artery (Fig. 1245) is felt above. At this situation the ureter is caught with forceps, and a stout ligature is carried around it and tied, and about three quarters of an inch more is freed by means similar to those employed before. The contents of the tube are then pushed upward, and the tube clamped to prevent their escape when the ureter is divided just above the ligature with long scissors passed into the wound from above. The stump of the ureter is now removed through an extension of the abdominal incision, or through the vagina. If by the latter way, the vagina is thoroughly cleansed, and the patient placed on the side opposite to the operation. The first and second fingers of the hand corresponding to the side on which the ureter lies, are passed up to the vaginal vault, and caused to oppose the fingers of the opposite hand (Fig. 1245). The uterine artery is raised out of the way by a digit of the inner hand between the fingers of which the ureter should lie. An assistant now introduces along the fingers of the operator to the vaginal vault a long, sharp-pointed scissors, pushing them through the thin-walled septum three fourths of an inch from the cervix into the abdominal cavity. The scissors are

FIG. 1246.—Operation of removing the lower end of the ureter through vaginal vault, Kelly's method. End of ureter exposed. Dotted line indicates direction of incision to expose vesical end of ureter.

withdrawn with the blades opened sufficiently to make an opening about three fourths of an inch in diameter. A long forceps is then carried through the opening, the ligature grasped, the ureteral stump drawn into the vagina, and held while the abdominal wound is being closed (Fig. 1246). The patient's condition permitting, she is placed in the lithotomy posture, and the vault of the vagina exposed by retractors, and the cervix pushed away from the opening and held by bullet forceps. The ureter is made tense by traction on the sutures, and a curved incision is formed in the vaginal vault from the junction of the anterior and lateral walls, forward and upward, beneath the base of the bladder to a point a little more than half an inch from the vesical end of the ureter. Through this incision the ureter is freed to the vesical attachment, and ligatured close to the wall of the bladder, and cut off. The vaginal wound is closed with sutures, leaving room for the exit of a gauze drain extending from the connective tissue above through the opening into the vagina.

In transperitoneal exposure of the kidney and ureter the large and small intestines are displaced toward the median line, and the posterior peritonæum is divided at the outer side of the colon, and reflected inward until the ureter is disclosed, when, if the operation be primary, the ureter is traced upward to the kidney, which is enucleated and removed in the usual manner (page 1033), leaving the ureter attached. In either primary or secondary operations the ureter is separated from above downward as far as practicable, ligatured, divided, and sterilized the same as before. The posterior peritonæum falls into proper position, therefore does not require sewing. The abdominal wound is closed throughout, except at the points left for the escape of such drainage agents as may be desired.

The Precautions.—Avoid injury of the peritonæum; the nerves of the lumbar plexus lying on the psoas may be mistaken for the ureter. Keep close to the ureter during the separation of it from the fatty environments to avoid injury of contiguous important nerves, especially when its surrounding tissue is in any way involved, this is particularly true in the broad ligament. In the transperitoneal incision important intestines lie in front and at either side that may be injured. Also, veins and arteries that may be ruptured. The ureter is not appreciable to sight or touch, as it lies beneath the peritonæum, and when this membrane is raised the ureter will be found attached to its under surface. It should not be forgotten that a transverse incision is better for examination of the kidney than the vertical, and therefore the former should be employed (extraperitoneal) when the kidney may appear to be a main feature of the operation. In such cases the raising out of the kidney and making tense the ureter affords opportunity to separate the latter with the fingers even down to the pelvis. This, however, should not be attempted if the ureter is imbedded in diseased tissues for fear of causing injury of close-at-hand vessels.

As the ureter is made fragile by disease, only careful traction on it should be made, and even this is often attended with breaking. Prompt control of the broken ends and thorough removal of the discharged matters should be exercised at once, to prevent dissemination of infection. Before ligaturing the ureter always push aside its contents; before dividing it, carefully protect the immediate tissues from possible infection; when divided sterilize the stump, turn the end inward, and close it with a suture. It may be necessary to ligature the uterine artery during the removal of the ureter, because of their intimate normal association (Fig. 179, vol. i). The separation of the ureter downward from the iliac artery to the broad ligament is difficult and complicated, because of the blindness of the procedure and the proximity of important structures. In incising the vaginal vault carefully avoid the uterine artery.

The Remarks.—*Fenger* considers pain in the side as a common sequel of nephrectomy with retained ureter. The same authority especially favors the inguinal incision and the route along the vas deferens as a guide to the distal end of the ureter. Rectal distention raises the bladder and renders the vesical portion easier of access. The extraperitoneal is the preferable route.

The Results.—In ureterectomy the results are favorable indeed to life.

Permanent fistula is a rare sequel of nephrectomy. Temporary fistulæ happen in from 7 to 25 per cent of the cases. Tuberculous complications beget permanent fistula.

The Relief of Valve Formation.—Valve formation at the beginning of the ureter causes an interrupted and perhaps permanent obstruction to the escape of urine from the pelvis, followed by distention of the pelvis with pus and urine.

In speaking of this operation, *Fenger* says: " The operation for valve formation can be best done by the extraperitoneal lumbar incision (Fig. 1204). The dilated pelvis or hydronephrotic sac is easily found, and is opened by a longitudinal incision. The opening of the ureter into the sac

FIG. 1247.—Operation for cure of valve formation, Küster-Trendelenburg method. *a, c.* Wall of pelvis of kidney. *b.* Opening of ureter into pelvis.

should be looked for, but can not always be found, as in some cases it is very narrow. In such cases it may be located by incising the ureter below the sac and passing a probe upward toward the pelvis (Fig. 1247). The valve or inner wall of the ureter running in the sac is now divided longitudinally from the opening in the sac, and the resultant wound treated in one of three ways: (*a*) By turning the flaps out and uniting them to the inner walls of the sac by sutures (Küster-Trendelenburg) (Fig. 1248); (*b*) by drawing the corners of the longitudinal incision together with one suture, transforming the longitudinal into a transverse wound, as in my operation; or (*c*) by uniting the wound longitudinally with numerous fine silk su-

FIG. 1248.—Operation for cure of valve formation, Küster-Trendelenburg method. *a, c.* Wall of pelvis of kidney. *b.* Ureteral opening slit up, flaps turned aside and stitched to the wall of the pelvis.

tures "; or by " taking in the two outer coats of the ureter and sac, and avoiding the mucous membrane " (Mynter).

In the first case in question *Fenger* practiced the following technique: After exposure of the kidney it was opened through the convex surface (*x*) with a Paquelin cautery, the opening dilated with forceps, and digital palpation was made of the pelvis and calices. Stone was not found, nor could the entrance of the ureter be dilated by the finger or probe. The posterior surface of the pelvis (Fig. 1249, *c, c*) was opened, and the borders of the wound were drawn apart. At the lower posterior portion of the inner wall the opening of the ureter (*d*) could be seen. After careful inspection and

the introduction of a bougie, supplemented by raising the pelvis, it was determined that the ureter was not connected with the most dependent part of the wall of the dilated pelvis, but, instead, with the posterior half, thereby causing the inner-lip of the ureteral opening to act as a valve and
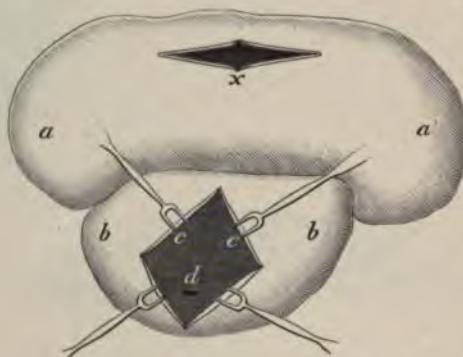
Fig. 1249.—Operation for cure of valve formation, Fenger's method. *a, a.* Kidney with dilated pelvis. *x.* Opening from nephrotomy. *b, b.* Dilated pelvis. *c, c.* Borders of opening made on posterior surface. *d.* Opening of ureter into pelvis.

close the aperture when fluid of "a slight or medium amount" was present in the pelvis. A greater degree of dilatation raised the valve and permitted fluid to escape. In order to overcome the valve formation, an incision of about a fifth of an inch in length was made vertically through the inner lip
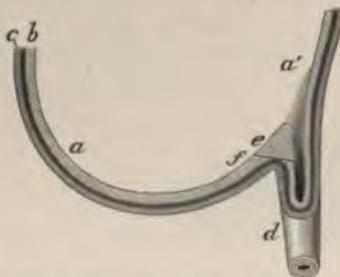
Fig. 1250.—Operation for cure of valve formation, Fenger's method. Dilated pelvis and the ureter. *a, a'.* The pelvis. *b.* The mucous membrane. *c.* The muscular and external coats. *d.* The ureter. *e.* The valve. *f.* Line of incision through valve.
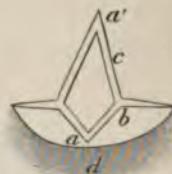
Fig. 1251.—Operation for cure of valve formation, Fenger's method. Valve seen from the pelvis, divided to illustrate operation. *b.* Opening of ureter. *c.* Divided valve. *d.* Inner wall of pelvis above opening of ureter. *a, a'.* Corners of incision to be united by suture.

of the opening (Fig. 1250, *e*). The vertical incision was then changed to a horizontal direction by uniting the terminal points (Fig. 1251, *a, a'*) with fine silk sutures. A No. 11 French bougie was readily inserted through the opening down the ureter, and withdrawn only far enough to permit the upper end to protrude through the kidney wound (*x*), where it was retained until the wound had healed. The incision into the pelvis (*c, c*) was

closed with ten fine silk interrupted sutures passed so as not to include the mucous lining. The kidney was then returned and nephropexy performed. The patient recovered without a fistula, and was cured of the cystonephrosis.

In the second case, after isolation of the ureter from the sac wall to permit the opening within to be seen through the pelvic incision, a grooved director was inserted into the ureteral opening from within, and the portion of sac wall that encroached on the opening was resected all around, and the border of the ureter was sutured to the divided borders of the sac wall, thereby securing an ample opening for a free escape of fluids into the ureter. The exploratory opening was then closed, as in the preceding instance, leaving a small aperture for drainage. Gauze was packed around the tube down to the opening in the sac. The fistula closed on the fortieth day, and the patient made a complete recovery.

Gerster, in a case of this nature associated with traumatic hydronephrosis, approached the kidney and upper end of the ureter extraperitoneally through the oblique incision. The opening of the sac and evacuation of its contents exposed to view the renal end of the ureter surrounded by a *cone-shaped projection* about a third of an inch in height, formed by the
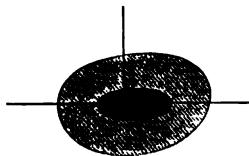
Fig. 1252.—Operation for cure of valve formation, Gerster's method. Cone-shaped projection surrounding renal end of ureter, divided at the sides and outer border.
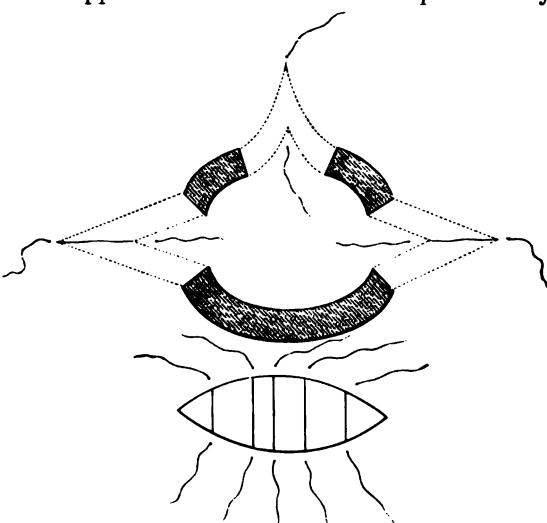
Fig. 1253.—Operation for cure of valve formation, Gerster's method. Points of division, the manner of approximation, and drawing down of lower lip shown.

eversion of the hyperæmic and thickened mucous membrane of the ureter (Fig. 1252). Under chloroform anæsthesia the rim of the orifice was divided at either side, also at the middle of the upper border, downward, far enough to sever the structures completely at each line of division (Fig. 1253). The upper and lower angles of each incision were united together with catgut and the intervals closed transversely in a similar manner. The lower portion of the rim was then drawn downward by the influence of the apposition of the borders of an oval-shaped dissection located half an inch below the opening formed by the removal of a mucous flap a third of an inch wide and three quarters of an inch long. Thus the nipple-shaped structure was for the time being converted into a shallow funnel-shaped depression. An elastic catheter was introduced, but removed within twenty-four hours

because of the pains produced in the bladder and penis. Under the influences of proper cleansing and dressing, the wound was reported as healed five months afterward. About eight months later, however, the wound reappeared with evidences of return of the ureteral constriction.

The Results.—Five operations have been performed thus far, two of which (Fenger's and Mynter's) were successful.

Stricture of the Ureter.—Stricture of the upper abdominal portion of the ureter has been treated successfully by the following methods:

Alsberg's Method.—In a case of urinary fistula following a lumbar nephrotomy for hydronephrosis, Alsberg dilated from above with fine bou-
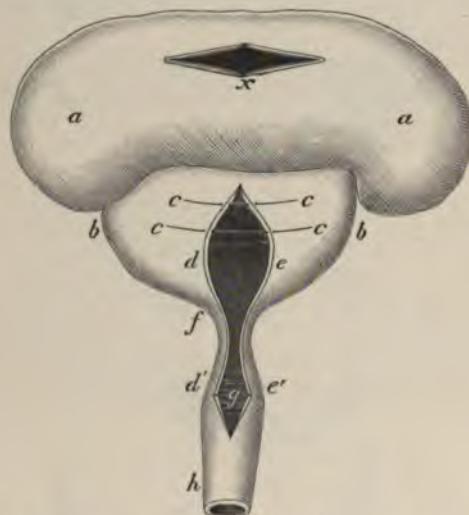
FIG. 1254.—Operation for cure of stricture of upper end of ureter, Fenger's method. *a, a.* The kidney. *x.* Nephrotomy opening. *b, b.* Dilated pelvis. *h.* Ureter below stricture. *f.* Stricture of upper end of ureter. *g.* Opening in ureter below stricture and extending through it into the pelvis. *c, c, c, c.* Sutures closing the upper half of the wound of the pelvis. *e, e'* and *d, d'.* Corresponding points of pelvis and ureter to be united by sutures after folding the ureter upon itself at the place of stricture.
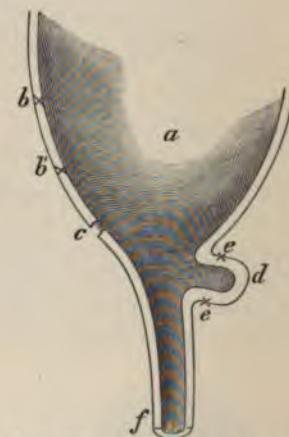
FIG. 1255.—Operation for cure of stricture of upper end of ureter, Fenger's method. *a.* The pelvis. *d.* Fold of ureter at place of stricture. *b, b'.* Sutures of wound in pelvis. *c.* Place of sutures between points *e, e'* and *d, d'* (Fig. 1077). *e, e.* Additional sutures needed to properly close borders of fold formed by approximations of *e, e'* and *d, d'* (Fig. 1077).

gies a stricture at the upper end of the ureter. After several days urine entered the bladder, and some months later the fistula closed. The hydronephrosis did not recur.

Kelly practiced successfully from below the dilatation of a stricture of the lower end of the ureter.

Fenger's Method.—In a case of nephrotomy for increasing intermittent pyonephrosis of long standing, Fenger, failing to find the intrapelvic opening of the ureter, raised the kidney out of the wound and made a longitudinal incision into the pelvis, not quite (Fig. 1254) an inch in length (*x*), drew the borders apart, and searched in vain for the opening of the ureter.

The abdominal wound was then extended to within an inch of the anterior superior spine of the ilium, through which the upper end of the ureter was
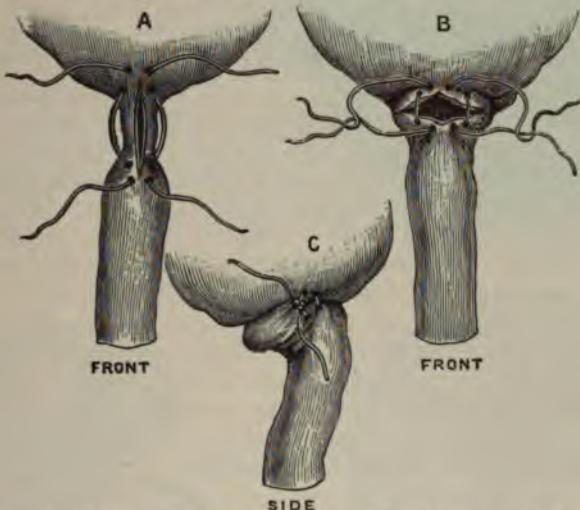
FIG. 1256.—Operation for cure of stricture of ureter, Morris's case. A. Stricture divided and sutures placed. B. Change of vertical to transverse direction by tightening sutures. C. Folding of the ureter from tying sutures.

found to be bandlike in appearance, and imbedded for nearly half an inch in cicatricial tissue. A short longitudinal incision, of sufficient length to admit a probe, was made into the ureter, at a point about three fourths of an inch below its pelvic opening, through which a metal probe was easily passed down the ureter, but upward it encountered obstruction, because of a narrow stricture immediately above. The ureter was liberated at the constricted portion, and the stricture divided upward on the probe as a guide. The upper part of the wound in the pelvis was independently closed with sutures (c, c and c, c). The patency of the tube was then re-established by uniting the divided borders of the wall of the ureter to the corresponding borders of the pelvis (Fig. 1255, d). A large drainage tube was passed into the upper part of the kidney, and a small one down to the pelvis and ureter. Gauze strips were introduced at the anterior and posterior surfaces of the kidney, and for about three inches around the ureter. The abdominal wound was united, except at the lower
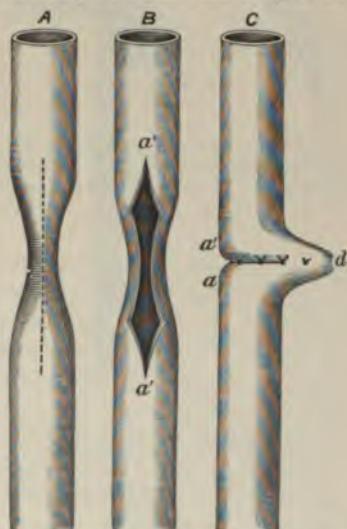
FIG. 1257.—Operation for cure of stricture of ureter, Fenger's method. A. Strictured ureter. B. Stricture divided. C. Extremities of incision (a a′) united. Ureter folded at d.

72

portion, which was kept open for drainage. The patient made a happy recovery in all respects. In another case Fenger practiced longitudinal ureterotomy at the upper end of the ureter, discovered and divided the stricture by a longitudinal incision, and repaired the wound by joining together the upper and lower ends with a suture, aided by folding the ureter on itself. The patient was cured.

Morris, after careful exploration of the calices and pelvis for stone, in a case of cysto-nephrosis, due to high stricture of the ureter, remedied the constriction as follows: He introduced a catheter through a small opening made into the infundibulum, and passed the instrument through the stricture into the bladder, then divided longitudinally the strictured portion upon the catheter. The longitudinal incision was then converted into transverse union by means of two fine silk sutures (Fig. 1256), thus curing the stricture. Closure of the exploratory parenchymatous incision, and immediate nephropexy, completed the operation. The wound healed by first intention, and the patient remained well at last report. Stricture of the ureter at a lower point may be cured by extraperitoneal longitudinal division, folding and sewing as in the preceding instances (Fig. 1257).

The Resection of the Ureter for Stricture.—In this procedure an inch or so of the tube is removed for stricture or other reasons, and the wound is repaired by restoration of the continuity of the duct. *Küster* first practiced the proposition in 1891.

Küster's Method.—After a lumbar fistula and vesical anuria, following a lumbo-nephrotomy, had existed for two years, Küster secured patency

Fig. 1258.—Operation of resection of ureter for cure of stricture, Küster's method. *x* indicates line of division opening into transverse section of ureter.
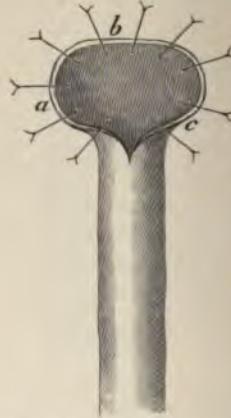
Fig. 1259.—Operation of resection of ureter for cure of stricture, Küster's method. End unfolded and sewed to opening in pelvis (*a, b, c*).

of the ureter in two months by the following plan: Failing to find the ureter through an extraperitoneal lumbar incision, he opened the pelvis of the kidney, disclosed the ureteral orifice, and with a probe located a stricture close to it. He divided the ureter transversely (Fig. 1258), just below the stricture and at the pelvic entrance, and closed the upper opening of the

ureter and removed the fragment. He then slit up the ureter below at one side for a short distance (x), and introduced it through an incision made in the wall of the pelvis of the kidney, unfolded the end and sutured its borders to those of the opening in the pelvis (Fig. 1259), closing the remaining portion of the latter with sutures. The fistula closed at the end of four months and the patient recovered. Several successful resections have been reported since this of Küster's.

Morris reports a case of painful interrupted hydronephrosis dependent on oblique association of the ureter with a diseased renal pelvis (Fig. 1260). He first laid freely open the ureter and pelvis by a continuous longitudinal

FIG. 1260.—Operation of resection of upper end of ureter, Morris's case. Showing opening into kidney substance and into the pelvis, and oblique association of ureter and dilated pelvis.

FIG. 1261.—Operation of resection of ureter, Morris's case.   Side of pelvis sewed up and ureter attached to dependent portion.

incision, and stitched together the corresponding borders of the respective parts.   This, however, was not satisfactory, and he excised at once three quarters of an inch of the ureter, closed the greater part of the pelvic incision, and sutured the end of the ureter to the lowest part of the sac (Fig. 1261), after the manner of Küster (Fig. 1259).   Then, fearing that the caliber of the opening would be much too small, and that the unfavorable condition of the patient and the extreme thinness of the wall of the ureter would lead to chronic fistula, the kidney was removed.

The Remarks.—Obstruction of the ureter from its abnormal connection with the pelvis of the kidney, because of kinking and compression at the pelvis by adventitious products and abnormal arrangement of vessels, is noted.   For relief of the first cause of obstruction, transplantation of the ureter to a more suitable location of the pelvis, with or without resection of the tube, is practiced.   For the last two, division of the constriction, without or with resection and implantation, is practiced.

The author offers no apology for introducing at this time the conclusions of *Van Hook* and *Fenger*. The logical results of their tireless labors, although modified by subsequent experience in many important respects, can not be exhibited too often as an earnest of commendable outcome and a stimulus to scientific endeavor.

Conclusions of Van Hook.—" 1. The extrapelvic portion of the ureter is most readily and safely accessible for exploration and surgical treatment by the retroperitoneal route.

" 2. Hence all operations upon the ureters above the crossing of the iliac arteries should be performed retroperitoneally, except in those cases in which the necessity for the ureteral operation arises during laparotomy.

" 3. The intrapelvic portion may be reached by incision through the ventral wall, the bladder, the rectum, the vagina in the female, the perinæum in the male, or by Kraske's sacral method.

" 4. The ureter is not only exceptionally well protected from injury, but by its elasticity and toughness resists violence to a remarkable degree.

" 5. The histology of the ureters furnishes most favorable conditions for the healing of wounds.

" 6. Longitudinal wounds of the ureter at any point heal without difficulty, in the absence of septic processes, under the influence of ample drainage.

" 7. In all injuries where the urine is septic before the operation, or where the wound is infected during the operation, drainage must be effected.

" 8. The chemic composition and reaction of the urine must be studied in all injuries to the ureter, the urine being rendered acid, if possible, and the specific gravity kept low.

" 9. The pelvis of the ureter is, *cæteris paribus*, the most favorable site for wounds of the ureter, since scar contraction is not so likely there to be productive of ill results.

" 10. In aseptic longitudinal wounds of the ureter occurring in the course of laparotomy, suture may be practiced and the peritonæum protected by suture.

" 11. Transverse wounds of the ureter involving less than one third of the circumference of the duct should be treated by free drainage (extraperitoneal) and not by suture.

" 12. In transverse injuries in the continuity of the ureter, involving more than one third of the circumference of the duct, stricture by subsequent scar contraction should be anticipated by converting the transverse into a longitudinal wound and introducing longitudinal sutures.

" 13. In complete transverse wounds of the ureter at the pelvis, sutures may be used if the line of union be made as great as possible.

" 14. In complete transverse injuries of the ureter in continuity, union must not be attempted by suture.

" 15. In complete transverse injuries of the ureter in continuity, union, without subsequent scar contraction, may be obtained by the writer's method of lateral implantation, as described (Fig. 1227).

" 16. In complete transverse injuries of the ureter very near the blad-

der, the duct may be implanted, but with less advantage, into the bladder directly.

"17. At the pelvis of the kidney, continuity, after complete transverse injury, may be restored by Küster's method (page 1076) of suture, provided the severed ends can be approximated by slightly loosening the ureter from its attachments.

"18. *Rydygier's* method (page 1063) of ureteroplasty in such injuries may be tried if other methods can not be utilized. The primary operation should at least fix the ends of the tube as nearly as possible together.

"19. In both transperitoneal and retroperitoneal operations the ureteral ends can be approximated by my method even after the loss of about an inch of its substance.

"20. The use of tubes of glass and other materials for the production of channels to do duty in place of destroyed ureteral substance must rarely be satisfactory, and, even if temporarily successful, the duct is almost sure to be choked by scar contraction.

"21. The implantation of the cut ends of a ureter into an isolated knuckle of bowel is objectionable: (1) Because the bowel is not aseptic; (2) because the operation is too dangerous.

"22. In injuries of the portion of the ureter within the pelvis, with loss of substance, the ureter should be treated as follows: If possible, the continuity of the ureter should be restored by the writer's method.

"23. If this is not possible, the ureter, if injured in vaginal operations, should be sutured to the base of the bladder with a covering of mucous membrane as far forward as possible, with a view to a future implantation or formation of vesico-vaginal fistula with colpocleisis.

"24. In injuries to the pelvic ureter during laparotomy, where the continuity can not be restored, and where temporary vaginal implantation can not be effected in the female or vesical implantation in the male, the proximal extremity of the duct should be fastened to the skin at the nearest point to the bladder.

"25. In ventral ureteral fistulæ opening near the bladder, the ureteral extremity may, in some instances, be planted directly into the bladder without opening the peritonæum.

"26. In cases where the ureter will not reach the bladder, a flap may be raised from the anterior vesical wall and reflected upward, extraperitoneally, to meet the ureter and form a tubular diverticulum.

"27. Such a flap may be elongated by a preliminary operation, transplanting the peritonæum back of the fundus, or by accurately suturing it there at a single sitting, so that median ventral fistulæ of the ureter may be cured if they open at any point an inch or more below the umbilicus.

"28. Symphyseotomy is a valuable and justifiable preliminary step in these plastic vesical operations.

"29. It is legitimate when both ends of a cut ureter open upon the abdominal wall to try Rydygier's method.

"30. Implantation of one or both ureters into the rectum is absolutely unjustifiable under all circumstances, because: (1) The primary risk is too great; (2) there is great liability to stenosis of the duct at the point of

implantation; (3) suppurative uretero-pyelonephritis is almost absolutely certain to occur, either immediately or after the lapse of months or years.

" 31. Ligation of the ureter to cause atrophy of the kidney is unjustifiable.

" 32. Extirpation of a normal kidney for injury or disease of the ureter is absolutely unjustifiable, except where the ureter can not be restored in one or other of the ways cited."

Conclusions of Fenger (1894).—" 1. Accidental wounds and subcutaneous ruptures of the ureter have not as yet been objects of direct surgical procedure upon the ureter at the seat of lesion (eighteen cases since 1848 recovering). It will be advisable, however, when and as soon as the diagnosis can be made, or when lumbar opening of a peri-ureteral cavity containing extravasated urine is made, to look for the seat of rupture, and, if practicable, to restore the continuity of the canal.

" 2. Catheterization of the ureters from the bladder for purposes of diagnosis of diseases of the kidneys has given valuable information affecting the decision for or against operation on the kidney.

" 3. In man, catheterization is practicable only through epicystotomy. The danger of this operation is steadily decreasing.

" 4. Catheterization of the ureter from the bladder as a curative measure for the evacuation of hydro- or pyonephrosis has occasionally been performed successfully. It is more difficult and more uncertain than nephrotomy and the attempt to find and remedy the stenosis of the ureter from the pelvis of the kidney.

" 5. Dilatation of strictures of the ureter by elastic bougies or catheters has been tried from the bladder by Kelly with temporary success, and from the pelvis of the kidney by Alsberg successfully; consequently this procedure is of use in isolated cases.

" 6. Permanent catheterization of the ureter from the bladder, a fistula, or an implanted ureter, is often tolerated only for a limited time, and must be employed with caution for fear of causing ureteritis.

" 7. Uretero-lithotomy, longitudinal incision over a stone for its removal, is a safe operation by the extraperitoneal method. The wound heals without stenosis. In extraperitoneal operations suturing is unnecessary, drainage down to the wound being sufficient.

" 8. Intraperitoneal ureterotomy should be done only when access outside of the peritoneal cavity is impossible, and it should be completed by careful suturing, covering with a peritoneal or omental flap and drainage.

" 9. Opening of the peritoneal cavity to locate the seat of the stone may occasionally be necessary, but, when the diagnosis is once made, ureterotomy for the removal of the stone should be done through an extraperitoneal incision, and the abdomen closed.

" 10. In valve formation or stricture of the ureter, causing pyo- or hydronephrosis or a permanent renal fistula, nephrotomy should be followed by exploration of the ureter in its entire course from the kidney to the bladder.

" 11. Exploration of the ureter as to its permeability should be done from the renal wound by a long, flexible silver probe (a uterine probe) or

an elastic bougie, either olive-pointed or not. If the bougie passes into the bladder the examination is at an end. The size of bougie that will pass through a healthy ureter is from nine to twelve, French scale.

" 12. If the pelvic orifice of the ureter can not be found from the renal wound it should be sought for by opening the pelvis (pyelotomy), or by incising the ureter (ureterotomy).

" 13. A longitudinal incision, half an inch to an inch long, in the posterior wall of the pelvis can be made while the kidney is lifted upward against the twelfth rib. This procedure is easy if the pelvis is dilated, but may be impossible if the pelvis is of normal size.

" 14. Operation for valve formation should be done through the wound in the pelvis. If the opening can not be seen or found from the pelvis ureterotomy should be performed immediately below the pelvis. A small incision should be made in the ureter and a probe passed up into the pelvis. The valve should be split longitudinally and the incised borders so treated as to prevent reformation of the valve.

" 15. A stricture in the ureter, if not too extensive, can be treated by a plastic operation on the plan of the Heinecke-Mikulicz operation for stenosis of the pylorus—namely, longitudinal division of the stricture and transverse union of the longitudinal wound. This method of operating for ureteral stricture seems to me preferable to resection of the strictured part of the ureter (Küster's operation) for the following reason: It is a more economical operation, and preferable when the elongation of the ureter is not sufficient to permit the two cut ends of the ureter after excision of the stricture, not only to come in contact, but even to permit of closure and invagination without stretching.

" 16. Resection of the upper end of the ureter and implantation of the distal end into the pelvis may be useful in rupture or division or stricture of the upper end of the ureter, as described by Küster.

" 17. In a similar case of stricture in the upper end of the ureter, especially if the ureter were not elongated or the kidney movable, I should prefer the plastic operation proposed by me, as it is easier of technique, and as it proved successful in my case of traumatic stricture in the ureter below the pelvic orifice.

" 18. The ureter is accessible through an extraperitoneal incision, from the twelfth rib down along and one inch anterior to the ilium and along Poupart's ligament to about its middle. This incision gives access to the upper three fourths of the ureter and down to within two or three inches above the bladder.

" 19. The vesical and lower pelvic portions of the ureter may be reached, as Cabot has pointed out, by means of the sacral operation, or Kraske's method, modified by osteoplastic temporary resection of the sacrum. In woman the vesical portion of the ureter is accessible through the vagina.

" 20. The vesical orifice of the ureter may be reached from within the bladder by suprapubic cystotomy in man, and by dilatation of the urethra, or suprapubic or vaginal cystotomy in woman.

" 21. Uretero-uterine fistulæ can be treated satisfactorily by plastic closure of the vagina or by nephrectomy. Implantation of the ureter into

the bladder is, under favorable circumstances, the operation of the future for this condition.

" 22. Uretero-vaginal fistulæ and congenital urethral or vaginal terminations of the ureter should be treated by vaginal plastic operation for dis-

FIG. 1262.—Instruments employed in catheterism of the ureter in the female.

a. Metal ureteral sound. b. Cystoscope with obturator removed. c. Cystoscope with obturator in place. d. Searcher. e. Applicator. f. Long forceps. g. Dilator of meatus and elastic ureteral catheter with stylet. h. Dentists' wax. A good natural or artificial light (Fig. 103) is of great importance in these examinations. Patient should be quiet when instrument is in ureter. An evacuator (Fig. 1265) is needed to remove fluid from around ureteral openings.

placement of the proximal end of the ureter into the bladder. If these attempts fail, and the kidney is not infected, extra- or transperitoneal implantation into the bladder should be done, and finally, as a last resort, nephrectomy.

" 23. Complete transverse wounds in the continuity of the ureter should be treated by uretero-ureterostomy after Van Hook's method of lateral implantation, if possible.

" 24. Complete transverse wounds of the upper end of the ureter should

be treated by implantation of the ureter into the pelvis of the kidney, as devised by Küster.

" 25. Complete transverse wounds of the ureter near the bladder should be treated by implantation into that viscus either by splitting the ureter or by invagination.

" 26. Loss of substance of the ureter too extensive to permit of uretero-ureterostomy, or too high up to permit of implantations into the bladder, may be treated by implantation on the skin or into the bowel.

" 27. Implantation into the bowel is objectionable on account of the infection which is almost certain to follow sooner or later.

" 28. Implantation into the rectum should not be resorted to when implantation into the bladder is possible.

" 29. Implantation on the skin in the lumbar region, or the abdominal wall, may have to be followed by secondary nephrectomy, which, however, is much less dangerous than the primary operation."

The Catheterism of the Ureter.—Catheterism of the ureter is now an accepted fact of practical importance. The introduction of a catheter or
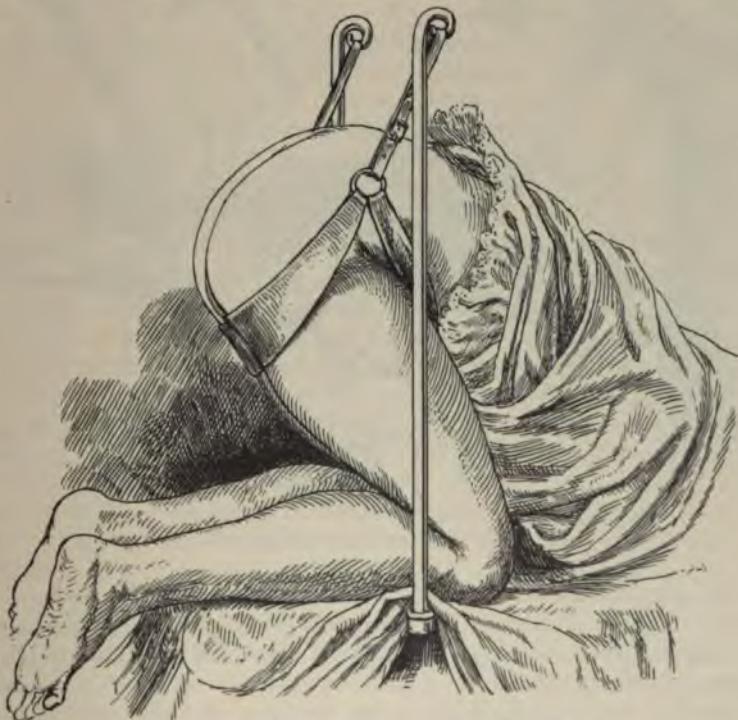
FIG. 1263.—The knee-breast position.

probe into the ureter for the purpose of diagnosticating the presence, nature, and situation of morbid conditions relating to the kidney and ureter, and their treatment, is an advance already assured, and now is an established means of investigation and treatment.

he technique of catheterism of the ureter is quite complicated and diffi-
of utilization except by those amply fitted by experience and instru-
al equipment for the purpose.

he act of catheterism of the female, as practiced by Kelly, is effected
of as follows: Cause the patient to empty the bladder while in the erect
ting posture; place the patient on the table in knee-breast (Fig. 1263)
vated-dorsal position (Fig. 1264) ; cause an assistant to separate and
apart the buttocks and labia ; cleanse the urethral orifice carefully
with boric-acid solution; dilate the ure-
thra cautiously; smear the end of the
speculum with a sterilized oleaginous
substance and apply the end of the in-
strument to the urethral opening and
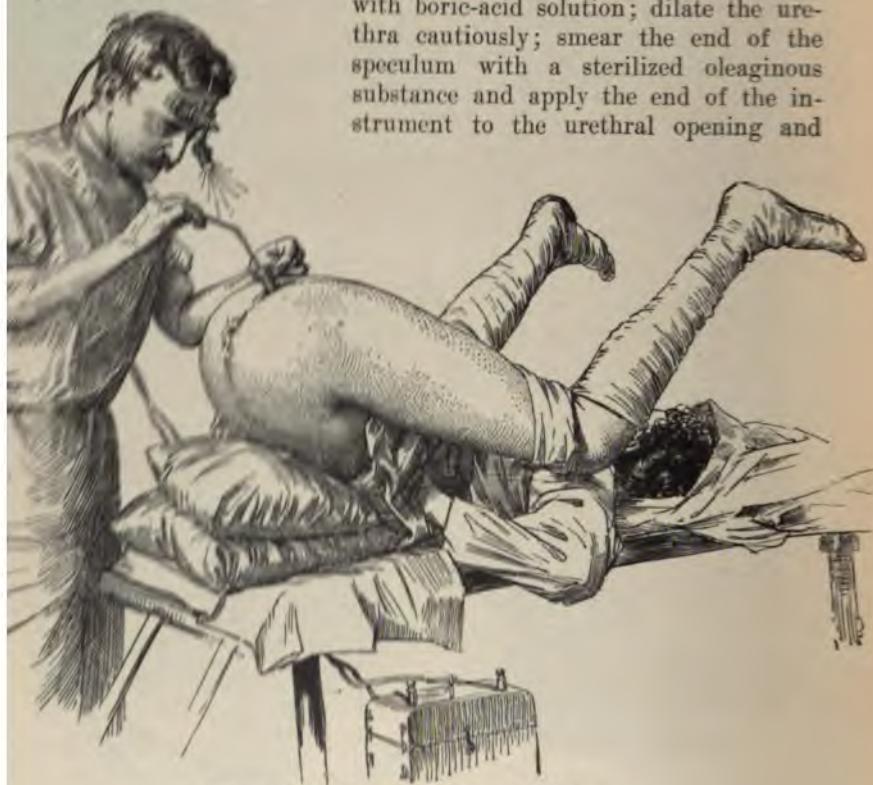
Fig. 1264.—The elevated dorsal position.

it into the bladder with a gentle sweep beneath the pubic arch ; with-
the obturator with a slight rotary motion, noting the entrance of
and distention of the bladder on the withdrawal; adjust the head
or and direct an assistant to hold the electric light so as to cause
reflected rays to fall within the bladder; inspect carefully the
sible walls of the organ by turning slowly the speculum in various
ctions; depress decidedly the instrument (knee-breast posture) to
g the vesical triangle into view, noting that this area is more deeply
cted than are the mucous membranes elsewhere in the bladder; turn
speculum to the right or left about fifteen to twenty degrees, and
rve the pink eminence denoting the position of the ureteral orifice;

watch it for a brief time (thirty seconds) to observe the ejection of urine; wipe the ureteral opening with aseptic cotton if the bladder or kidney be diseased; grasp the catheter, steadied with a stylet, and lubricate the extremity; introduce the extremity into the ureter and carefully push it up a little way; partially withdraw the stylet as the catheter is made to advance; push the latter upward into the pelvis of the kidney if desired; withdraw the speculum and retain the patient in position if the catheter is soon to be removed, if not, place her upon the side, carefully retaining the catheter in place during the change of posture. *If the object of the introduction is to flush the pelvis of the kidney,* the catheter should be small enough to permit a refluence along the outer surface of the instrument into the bladder, from which it may be caused to escape through a second catheter introduced through the urethra by the side of the first. If the fluid introduced into the kidney be colored its escape from the bladder will then be convincing of the completeness of the circuit. If the condition of the kidney is to be determined by the characteristics of the urine, a metal catheter should be employed with a rubber-tube attachment to the outer end by means of which the urine can be collected. If with one catheter in place the bladder be thoroughly cleansed and completely emptied, the urine withdrawn from it thereafter will indicate the condition of the opposite kidney. The catheterization of both kidneys will enable one to determine the condition of either by the characteristics of the respective urines. If the ureter or kidneys is to be sounded for stone a metal instrument may be employed (Fig. 1262, *a*), or one tipped with wax, or with an extremity readily roughened by friction. Cases in which, because of weakness, great weight, or other cogent reasons—the restrained postures already described are not suitable for catheterism, *Kelly* introduces the catheter with the patient lying on the back and the thighs drawn upward. The bladder is emptied, the cystoscope introduced, the outer end strongly elevated, the inner turned to the right or left side of the base of the bladder, and the mucous membrane at the end of the speculum is examined for the opening. If it be not found at first the instrument is withdrawn to the neck of the bladder to determine its exact position. It is then pushed inward to one side, hoping to bring the orifice within the field. Sometimes it can be promptly accomplished in this way; again, it may be necessary to pass the end of the instrument lightly across the mucous membrane, and not infrequently the use of the searcher (*d*) is needed to detect the opening. One not thoroughly familiar with the practice need hardly expect to succeed under these circumstances.

Catheterism of the ureters in the male can be accomplished through the straight tube, as has just been described in the female. However, ureteral catheterism in the male is better accomplished with the aid of a cystoscope.

The technique of catheterism at first relates to the introduction of the cystoscope, which is readily done after the manner of the introduction of a lithotrite. When this is accomplished turn the beak downward toward the neck of the bladder and turn on the light; seek the median line at the neck of the bladder and rotate the beak slowly to either side within an inch

of the median line, with the instrument at an angle of forty-five degrees, carefully watching for the opening of a ureter, which may easily be found (or remain invisible), having a slit-like, or crater-like form, or a slightly elevated appearance; cease all movement of the instrument when the site of the opening comes into view and await the diagnostic ejection of urine; bring the lens as near to the urethral orifice as practicable when the escape of urine is noted; adjust the catheter carefully to the cystoscope and cautiously introduce it (perhaps after many trials) into the ureter about two inches; turn out the light, remove the cystoscope, leaving the catheter tied in place the same as a filiform bougie (Fig. 1488) and connected with a sterilized bottle to gather the urine.

The Remarks.—If after five or ten minutes the orifice is not found, remove the instrument and introduce a small amount of fluid, thus perhaps raising from off the opening a mucous fold. The examination should be made patiently and carefully near to the neck of the bladder for apparent reasons (Fig. 1547). Carefully note the character of the escaping fluid. If one kidney be inactive temporary confusion may follow, unless the opening from the other be sought for and found. The passage along the ureter of a catheter is similarly done, and for like reasons, in both sexes.

The General Precautions.—In catheterism of the ureter thorough asepsis should be practiced in all respects to prevent infection of the kidney.

FIG. 1265.—The evacuator.

The urethra should be stretched carefully, so as not to cause needless dilatation and loss of power. The instruments should be introduced with relation to the curve of the arch of the pubis to avoid injury of the urethra. Careful introduction of instruments into the ureter and kidney is urged to prevent perforation of the former, and puncture of the latter, structure.

The General Remarks.—If fluid obscures the ureteral orifice, withdraw it by means of the evacuator (Fig. 1265). A catheter may be kept in the ureter for several hours, and even for three or four days in some cases. Flexible instruments are the safer for use. Catheters employed in the

kidney should be longer than those limited to the ureter. Wire stylets may be inserted or not in either case, depending on the stiffness of the catheters and the need for increased pressure in the introduction. Metal catheters are used when the canal is constricted or tortuous. Metal and hard-rubber bougies for dilatation are serviceable in those cases. If a bougie (with the tip covered with dentists' wax, Fig. 1262, *h*) be pressed against a stone in the ureter or kidney the wax will bear evidence of the nature of the contact. The knee-breast posture is better than the elevated dorsal for stout patients. The X ray lessens the need of catheterization.

An electric headlight (Fig. 111, vol. i) is economic and advantageous in many instances. It frequently happens that the most cautious use of these instruments is followed by bleeding from the ureter. In very nervous patients, and at a first examination, general anæsthesia may be required. A four-per-cent cocain solution will deaden the sensibility of the urethra and bladder sufficiently for the purposes of the steps of the procedure.

Catheterism of the ureters in the female is quite easily accomplished by means of the ureter cystoscopes of Brenner, Casper, Nitze, Albarran (page 1375), and others. But familiarity with their use is quite as essential to success as with the method of Kelly just described.

Cocain anæsthesia contributes to the comfort of the patient, and correspondingly facilitates the conduct of the procedure. The presence in the bladder of a small amount of fluid is essential for the purpose.

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The urine from the ureters is then collected in separate vessels (right, left) and examined chemically, microscopically, and bacteriologically to compare the output of one kidney with that of the other and to determine the functional ability of each.

The Differentiation of Urines (Segregation).—In cases in which for any reason ureter catheterism is not available, a differentiation of the fluids may be sought by other means. The closure of one ureter by pressure variously applied, and of a ureter opening by similar means, the employment of suction at the vesical orifices (Fenwick), and the separation and collection of the fluids by special apparatus (Harris), are all ingenious, and each is effective in conformity with the period of its inception.

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double catheter (*a*, *a*), each being separate throughout, but both being in-
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thus giving it the appearance of a single flattened tube. Each catheter is
separately movable about its longitudinal axis within the sheath. On the
flattened surfaces and the lateral portions of the semicircular surfaces are a
number of small perforations. The distal extremity of each catheter is
round and curved in the same plane as the proximal extremity, forming
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Introduce the instrument into the bladder with the membrane sheathed in the shaft; turn down the metallic catheters until their extremities are vertical, and immediately the urine flows; withdraw the instrument until its beak feels the resistance of the anterior wall of the bladder.

Push out the rod attached to the membrane, with the shaft of the instrument almost horizontal, until the figure marked upon the rod coincides with your estimate of the bladder capacity.

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Push out the rod attached to the membrane, with the shaft of the instrument almost horizontal, until the figure marked upon the rod coincides with your estimate of the bladder capacity.

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support provided for the purpose; hang from the instrument two centrifuge tubes for collecting the urine.

After collection of urine, replace the catheters in a vertical position; withdraw the membrane until the zero on the shaft appears, and extract the instrument. A completer description of these instruments can be found in special works devoted to the topic.

OPERATIONS ON THE SPLEEN.

The operations performed on the spleen are splenectomy, splenopexy, aspiration, and splenotomy.

The Anatomical Points.—The spleen lies between the fundus of the stomach and the diaphragm. The lower end reaches to the first lumbar spine; the upper to the ninth dorsal spine; the external surface corresponds to the ninth, tenth, and eleventh ribs. The inner end is distant about an inch and a half from the median plane of the body, and its outer end about reaches the midaxillary line (Quain). The long axis corresponds to the tenth rib. The peritonæum is reflected at the hilum, incloses the splenic vessels, and together they constitute the pedicle of the viscus in a surgical sense. The suspensory ligament of the spleen is a double fold of peritonæum connecting the organ with the under surface of the diaphragm; the left crus of the diaphragm, the suprarenal capsule, and the flexure of the colon lie behind it. The splenic artery is large, tortuous, and gives off numerous branches near the hilum, some of which, the vasa brevia, pass backward to the stomach. These branches should be avoided in the ligature of the pedicle if possible. The splenic vein is large and lies below the artery. These vessels are surrounded by a minimum amount of connective tissue, hence they are quite easily isolated and ligatured singly.

The anatomical relations suggest the tendency of adhesion of the spleen to, and abscess invasion of contiguous viscera, and especially of the diaphragm, also the need of resection of the ninth, tenth, and perhaps the eleventh ribs in opening abscesses superiorly located, by the way of the pleural cavity and diaphragm.

Splenectomy. The spleen is approached for the purpose of removal (splenectomy) in case of disease or injury, and also for examination and repair in the latter instance.

The Operation.—After thorough aseptic preparation of the patient, make an incision through the median line into the outer edge of the left rectus muscle down to the peritonæum, supplemented by a transverse incision through the rectus in the first instance if desired; push aside the intestine, expose the spleen and isolate it with broad flat sponges or wipers; ligature and divide the adhesions, also the gastro-splenic, the lieno-renal, and phrenico-splenic ligaments, carefully avoiding traction upon the latter; depress the parietes to lessen traction on the pedicle; commencing at the lower extremity, carefully expose and deliver the viscus; cautiously locate and secure the pedicle, either *en masse* or by separate ligature of the vessels; divide the pedicle with scissors or cautery, tying independently, perhaps, the open ends of the vessels for better security; remove the organ

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Cocain anæsthesia contributes to the comfort of the patient, and correspondingly facilitates the conduct of the procedure. The presence in the bladder of a small amount of fluid is essential for the purpose.

Tilden-Brown has devised an instrument which he calls his "compound composite ureter-cystoscope" (Fig. 1555), by means of which he is able to catheterize the one or both ureters, as well as to examine the bladder. By means of this instrument ureter catheterism is readily accomplished. The bladder is distended by a transparent medium (boric-acid solution or saline solution or by warmed air), and the light-carrying sheath with its obturator is inserted into the viscus. The obturator is replaced by the single or double catheterizing telescope, which carries the catheter or catheters, as the case may be. The light is turned on and the ureter opening sought for, and when distinctly seen, directly in line with the shaft of the instrument, the catheter is gently pushed forward and observed to enter the mouth of the ureter and bulge inward its intramural portion.

The urine from the ureters is then collected in separate vessels (right, left) and examined chemically, microscopically, and bacteriologically to compare the output of one kidney with that of the other and to determine the functional ability of each.

The Differentiation of Urines (Segregation).—In cases in which for any reason ureter catheterism is not available, a differentiation of the fluids may be sought by other means. The closure of one ureter by pressure variously applied, and of a ureter opening by similar means, the employment of suction at the vesical orifices (Fenwick), and the separation and collection of the fluids by special apparatus (Harris), are all ingenious, and each is effective in conformity with the period of its inception.

Harris's Method.—The meth *   ʼ
rately the unmixed urine of
ment (Fig. 1266) devi

FIG. 1268.   FIG. 1269.   FIG. 1270.

Fig. 1268. Tumor of pancreas. Stomach and ... below it. The posterior wall of the lesser peritoneal cavity and the gastro-hepatic ... omentum are in front.

Fig. 1269. Tumor of pancreas. Stomach above and colon below. The posterior wall of the lesser peritoneal cavity and the gastrocolic omentum are in front.

Fig. 1270. Tumor of pancreas. Stomach in front, colon below it. Less advanced than preceding. The posterior wall of the lesser peritoneal cavity and the gastro-colic omentum are in front, but not pushed forward as in Fig. 1269, this tumor not being a large one.

... into and through the lesser peritoneal cavity (Fig. ... This route is suited to tumors located at the ... ... of the stomach.

2. From the greater peritoneal cavity (Fig. 1078, c), between the colon and stomach, through the gastro-colic omentum (Fig. 1269), into and through the lesser peritoneal cavity (Figs. 1269 and 1270). After raising the omentum, this route is direct and affords ample room and good inspection. However, great care should be exercised in dividing the gastro-colic omentum, and in manipulation of it thereafter to avoid impairment of the circulation of this structure and consequent gangrene of the colon.
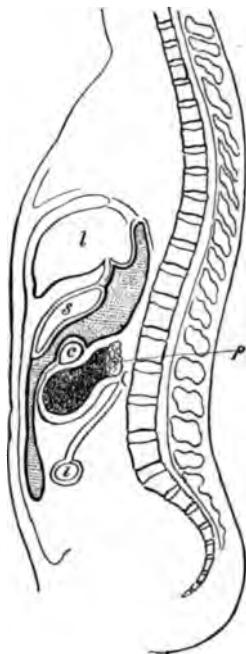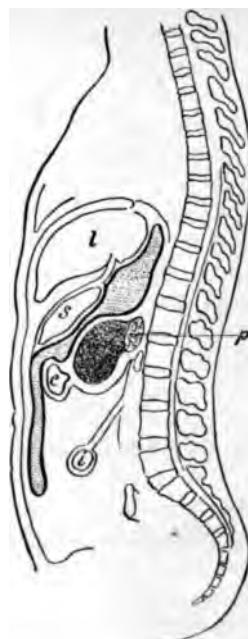
<div align="center">FIG. 1271.   FIG. 1272.</div>

FIG. 1271.—Tumor of pancreas. Stomach and colon both in front of it. The tumor lying between the layers of the transverse mesocolon. The lower layer separating it from the great peritoneal cavity.

FIG. 1272.—Tumor of pancreas. Stomach and colon both above it. Farther advanced than the preceding. The tumor pressing upon the lower layer of the transverse mesocolon. A larger development of growth (Fig. 1267).

3. From the greater peritoneal cavity (Fig. 1078, c) beneath the transverse colon, through the inferior layer of the transverse mesocolon into the space between its two layers (Figs. 1271 and 1272).

4. Through the abdominal wall as for exposure of the kidney (Fig. 1101, i). This route is subperitoneal and usually directed to the tail of the pancreas.

5. From the greater peritoneal cavity to the duodenum, through its peritonæum, alongside the bowel to the head of the pancreas (Küster).

Injuries of the Pancreas.—Injuries of the pancreas are operative injuries and those from external violence. In instances of each of these classes the aim should be to arrest hæmorrhage and prevent contamination of the

serous and other tissues by the natural and pathologic products of the injured gland. For the former purpose surface ligature and through-and-through sutures are employed; for the latter, inturning of the injured part and deep sutures to bring the peritoneal borders in contact; tamponing is safer for the latter purpose and may be needed for the former.

The Remarks.—In injury due to operative violence, the indications are the same as for other kinds, and the means of attainment need not differ; however, the dangers are much less, as prompt means of relief are then at hand. Operations on the stomach, complicated with injury of the pancreas, have a decidedly increased death rate.

The Results.—The importance of tampon drainage is shown by the fact that of 12 cases due to external violence, such as blunt force, stab and gun-shot wounds, 8 were drained, with 6 recoveries. Of 4 undrained, 3 died (Mikulicz).

Mikulicz reports 45 cases of injury to the pancreas, 21 from penetrating and 24 from blunt violence; of the former, 12 were gunshot and 9 were stab wounds; 5 of the gunshot were operated on, 3 recovered, and 2 died. Seven were not operated on; all died. The stab wounds (9) were operated on; 8 recovered and 1 died. The stab wounds were simpler than the gun-shot, therefore less dangerous. Of the 24 due to blunt violence, 11 were operated on and 7 recovered; of 13 not operated on, all died.

Inflammation of the Pancreas.—Since in a large number of instances acute pancreatitis is the result of infection, the preparation for surgical treatment in such cases would be quite clear, if one's opportunity and knowledge were correspondingly assured. The exposure and walling off with gauze of the diseased area, followed by multiple deep incisions, thorough cleansing, and complete drainage as in other similar cases elsewhere in the body, should result in a correspondingly favorable outcome. In such cases it is advised to drain the omental bursa through a small incision made below the umbilicus (Lund), also through the loin (Robson), or perhaps by resections of parts of the tenth and eleventh ribs (Mikulicz).

Chronic Pancreatitis.—Since chronic pancreatitis can easily be mistaken for malignant disease, the uncertainty hinders and often prevents operative procedure for relief of the former. However, inasmuch as chronic pancreatitis commonly results from infection of the bile ducts and from stone impaction, especially in the ampulla of Vater, operative practice directed to draining the bile ducts, or for removal of *impacted calculi*, is in order. Cholecystostomy, cholecyst-enterostomy with entero-anastomosis four inches below (Mikulicz), and choledochotomy, should each be considered and employed according to the demands revealed by an abdominal incision, which, of necessity, will be exploratory. Gallstones have been removed by free incision into the end of the pancreas.

The results are so favorable as to suggest avoiding needless delay and the greater lessening of the infective processes arising therefrom. In 36 cases, 13 recovered and 5 died (Mikulicz).

Pancreatic Apoplexy.—Pancreatic apoplexy may be a complication of acute inflammation of the organ or be dependent on a general hæmorrhagic

dyscrasia, independent of, or connected with pancreatitis. Inasmuch as operative procedure in dyscrasic cases is here, as elsewhere in the body, of the gravest import, careful discrimination and consideration should always precede operative interference. Avoid, as a rule, operative interference in dyscrasic cases, and when operation is contemplated the patient should be thoroughly prepared therefor (page 7, vol. i), and also the means of contention against the loss of blood and its effects should be well in hand (page 66, vol. i). The operative technique of each form is practically alike. A free abdominal incision in the median line, the approach to the omental bursa through the gastro-colic or gastro-hepatic omentum (Fig. 1268 *et seq.*) as seems fitting, the walling off of the field of operation with gauze, the opening of the sac, the elimination of its contents and flushing with hot saline solution, the removal of shreddy tissue, and finally the introduction of a drainage tampon, are the logical measures of procedure, free bleeding demanding a firm tamponade.

Abscess of the Pancreas.—The surgical treatment of abscess of the pancreas when united to the abdominal wall differs in no essential respect from that of abscess of the liver (page 966). When the purulent collection is not prominent, then the route of approach (page 1096) will be governed by the seat of the major part of the purulent collection, together with the situation most available for good drainage for the avoidance of leakage. Aspiration ought not to be practiced unless operation follow at once, and even then it is better to first expose the sac before puncture. The walling off with gauze, the turning of the patient to one side, the aspiration of and opening the sac, the washing it out, and the subsequent drainage are matters already described (page 966) and need not call for mention now. If conditions will allow, the walls of the sac and of the abdominal wound should be united before incision.

Cysts of the Pancreas.—The measures for the treatment of cysts of the pancreas are: 1. Aspiration; 2, evacuation and drainage, cyst sewed to the abdominal wall; 3, extirpation, partial or complete.

Aspiration.—Aspiration has nothing to commend it except perhaps the forestalling of impending rupture. The danger of leakage thereafter should prompt as early as possible operation.

Evacuation and Drainage.—Make a short, straight, vertical incision in the median line down upon the tumor and arrest hæmorrhage. *If adhesions be present,* respect them, and remove much of the contents of the cyst with an aspirating trocar; incise the cyst, evacuate the remaining contents, stitch the edges of the incision to the borders of the abdominal wound, and introduce a drainage tube. *If adhesions be not present,* carefully incise and draw aside the overlying omentum and ligature the bleeding points; introduce the aspirating trocar and remove enough of the fluid to relax the walls of the cyst, which are then seized with catch forceps and drawn well forward into the abdominal wound; turn the patient to one side and incise the cyst wall sufficiently to admit a large drainage tube, after which the borders of the cyst are sewed to the abdominal incision.

The amount of fluid subsequently discharged is often great, requiring careful oiling of the surface and also frequent changing of the dressings to

prevent irritation. The tube is shortened from time to time, and the size lessened as shrinkage of the sac takes place.

Extirpation, Partial or Complete.—Complete extirpation is seldom necessary and rarely attainable, and therefore not to be attempted without excellent reasons. If the cyst project from the opening, be free from important vascular or visceral adhesions, and have a small pedicle, extirpation may be fitly attempted. The pedicle may be ligatured (Clutton), clamped (Poucet), or severed with thermo-cautery (Kosmoski). In rare instances the attachment can be enucleated if pancreatic tissue be not extendedly attached upon the surface.

The Results.—In 15 cases of complete extirpation, 13 recovered. In 7 cases of partial extirpation, 4 died (Robson). In an old series of 113 cases thus treated, 11 recovered.

The Remarks.—As in abscess of the liver, the cyst may be opened in two stages. Usually the cyst is underneath the gastro-hepatic omentum (Fig. 1077, *a*). When exposed the hand should be carried around it to determine its origin, adhesions, size of pedicle, etc. The seat of counter drainage is best determined by passing the hand into the sac and noting the nearness of approach to either side below the last rib with the fingers, at which point an opening may be made, carefully avoiding the colon. When union of the cyst wall with the abdominal wall can not be made because of a scanty sac, either of the following expedients may be practiced: 1. Introduce into the cyst a tube surrounded with gauze, much of the lower end of the tube being uncovered. 2. Confine a tube in place in the cyst with a purse-string suture carried around the point of entrance. 3. The omentum may be utilized to form a barrier to protect the peritoneal cavity. 4. Expose the cyst, evacuate its contents with a needle, and introduce gauze packing down to the cyst, permitting it to remain for three days, when, on removal, a secure passage will have formed through which the cyst can be safely incised.

The Results.—Of 65 cases, 7 died; of 84 cases, 5 died.

Solid Growths of the Pancreas.—Carcinoma, sarcoma, adenoma, and lymphoma are met with in the pancreas.

In 23,611 autopsies, carcinoma was found in 29 instances. The head of the organ is afflicted more often than all other of its parts combined. Primary sarcoma is rare, but secondary melanotic sarcoma is not infrequent. Several cases of adenoma are recorded, and tubercle and syphilis are present occasionally.

The Treatment of Solid Tumors.—Medicine avails nothing; no definite technique can be laid down for removal of the tumor. The approach to and exposure of a tumor is along the lines of technique already stated on numerous occasions relating to abdominal operations.

The following principles of action formally announced by Senn are yet of importance in this connection:

" Partial excision of the splenic portion of the pancreas is indicated in cases of circumscribed abscess and malignant tumors, and in all cases where the pathological product can be removed completely without danger of compromising pancreatic digestion or inflicting abdominal injury upon important adjacent organs.

" Ligation of the pancreas at a point or points of section should precede extirpation as a prophylactic measure against troublesome hæmorrhage and extravasation of pancreatic juice into the peritoneal cavity.

" The formation of an external pancreatic fistula by abdominal section is indicated in the treatment of cysts, abscesses, gangrene, and hæmorrhage of the pancreas due to local causes.

" Abdominal section and lumbar drainage are indicated in cases of abscess or gangrene of the pancreas where it is found impossible to establish an anterior abdominal fistula.

" Thorough drainage is indicated in cases of abscess and gangrene of the pancreas with diffuse burrowing of pus in the retroperitoneal space.

" Removal of an impacted pancreatic calculus in the duodenal extremity of the duct of Wirsung, by taxis, or excision and extraction, should be practiced in all cases where the common bile duct is compressed or obstructed by the calculus and death is threatened by cholæmia."

The Remarks.—The abdominal incision is sometimes made over the most prominent point of the tumor, in the belief that it will correspond more nearly to the seat of the exciting cause. *Leith* advises a posterior incision at the left side, under the twelfth rib, through which the fingers along the outer border of the quadratus lumborum seek the kidney and tail of the pancreas. Here the lesser peritoneal cavity can be entered through the mesocolon or peritonæum. Exploratory puncture can be practiced for diagnostic purposes, but with the danger of leakage and peritonitis, and also of injury of contiguous structures. The aspiration treatment is not only dangerous but ineffective, as the fluid rapidly reaccumulates. Extirpation of the cyst ought not to be attempted except for some weighty reason, but unhealthy isolated parts of the cyst wall should be removed when practicable, provided their loss does not require that undue traction be made to join the borders to the abdominal opening. If there be good reason for the act, preliminary incision with gauze packing can be practiced to insure serous union before evacuation of the contents.

Subphrenic Abscess.—The expression, subphrenic abscess, is applied to a collection of pus of greater or lesser amount located in the subphrenic space.

The Anatomical Points.—Practically considered, the subphrenic space is limited above by the diaphragm, below by " the upper horizontal plane " of Quain, which corresponds to the second lumbar vertebra behind to a point two inches above the navel in front, and substantially to the eleventh costal cartilages at either side. Essentially this space is divided above into the right and left portions by the falciform ligament of the liver. The norml contents of these spaces and their comparative relations is a matter of importance which can be easily known by consulting a standard work on anatomy.

The Varieties of Subphrenic Abscess.—Inasmuch as the viscera directly concerned in this form of abscess are often incompletely covered with peritonæum, it follows that subphrenic abscess may be extraperitoneal or intraperitoneal, according to the relations of the serous covering to the seat of the causation and to the pus location. *Abscess between the liver and the diaphragm* may be either extraperitoneal or intraperitoneal, according to the relations of the reflections of the peritonæum upon the liver (Fig. 1273).

The extraperitoneal variety in this instance is located directly between the liver and the diaphragm, therefore between the anterior and posterior parts of the coronary ligament (Fig. 1273, 2), originating in the great majority of instances in the liver itself. The same may be said of the left lobe of the liver contiguous to the triangular ligament.

The intraperitoneal varieties in this instance lie respectively between the serous layers of the anterior (Fig. 1273, 2) or posterior parts of the coronary ligament of the liver, of which the former is the better example. An abscess may be limited to either of these places, especially the former, but this is very unusual, since the spaces are parts of larger ones lying below from which pus frequently extends upward into them.

It is evident, especially in the extraperitoneal instance, that the tumor will not encroach on the subphrenic region, also it is apparent that it will intrude decidedly on the thoracic cavity, perhaps perforating the diaphragm.

In the intraperitoneal varieties at this situation, of which the one indicated (Fig. 1273, 2) is an apt illustration, the causes and complications are quite like the extraperitoneal kind, though they may open into the cavities below, of which originally they were a part.

In abscess below the liver an extraperitoneal (retroperitoneal) form is found lying, not infrequently, beneath the posterior layer of the peritonæum corresponding with the lesser omental sac (Fig. 1273, 3), and following extraperitoneal, duodenal, appendicular, and some other like visceral perforations. Also this form depends on burrowing suppuration due to disease of the kidney, the œsophagus, contiguous bony structures, etc. In this form the pus elevates the peritonæum, pushes forward the intestines and the mesentery, displaces the stomach, invades the diaphragm, and possibly encroaches on the abdominal wall in extreme cases. This form happens most frequently at the right side.

The intraperitoneal kinds are two in number, one located in the great peritoneal cavity, i. e., above the stomach (Fig. 1273, 4); the other in the lesser cavity, i. e., below the stomach (Fig. 1274, 6). Both are often dependent on perforation of that organ. *Those above the stomach* are always to be found between the liver and the stomach and often extend forward so as to invade the anterior and upper part of the great peritoneal cavity, sometimes causing marked protrusion of the abdomen and extending well above the liver (Fig. 1273, 4), the extent in all directions being controlled in part by the limiting adhesions that arrest its progress. Under certain conditions the infliction may invade the great peritoneal sac by passing down in front of the greater omentum. *Those below the stomach* form in the lesser peritoneal cavity, distend the sac, extend behind the liver, push forward the stomach, displace the colon, press against the abdominal wall, forming a tumor of decided presence, and may, conditions permitting, invade the cavity of the great omentum itself. However, in many instances, these various abscesses do not assume decided dimensions. The abscesses located in the lesser sac are bilateral. Those in the greater and those behind the peritonæum (retroperitoneal) may be either bilateral or unilateral, according to the cause, situation, and amount of the morbid products (Fig. 1275, b). It should be kept in mind that many of these

abscesses contain air for apparent reasons, and may therefore be mistaken for morbid conditions of the thorax with similar contents (Fig. 1275). These abscesses arise from various causes, and nearly half of them are the result of lesions of the stomach, duodenum, cæcum, appendix, liver, and biliary passages, and substantially in the order mentioned.

The Treatment.—Subphrenic abscess usually ends fatally unless relieved by operation, and the prompter the relief is afforded the better are
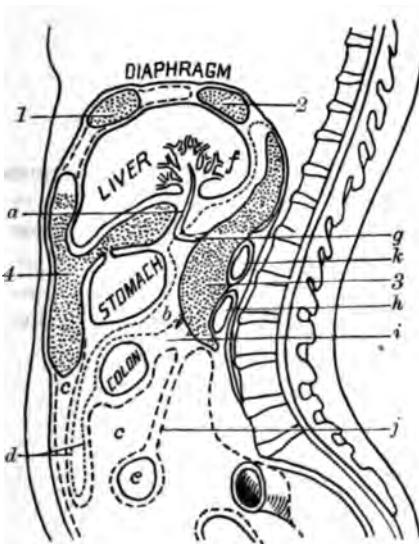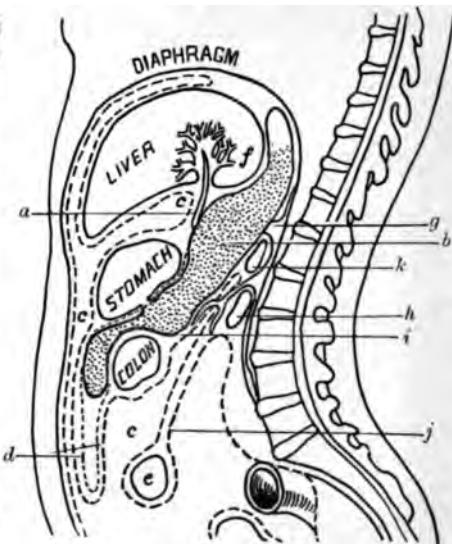
FIG. 1273.   FIG. 1274.

FIG. 1273.—The relations of the stomach, etc., to the peritonæum and contiguous organs. *a.* Gastro-hepatic or lesser omentum. *b.* Lesser peritoneal cavity encroached on by retroperitoneal abscess. *c, c.* Greater peritoneal cavity. *d.* Folds of great omentum. *e.* Small intestines. *f.* Liver. *g.* Cœliac axis. *h.* Duodenum. *i.* Transverse mesocolon. *j.* Mesentery. *k.* Pancreas. 1. Abscess directly between liver and diaphragm (intraperitoneal). 2. Abscess between liver and diaphragm (extraperitoneal). 6. Abscess behind the peritonæum (retroperitoneal). 4. Abscess above and often due to perforation of the stomach (intraperitoneal). (See Fig. 1078.)

FIG. 1274.—The relations of the stomach, etc., to the peritonæum and contiguous organs. *a.* Gastro-hepatic or lesser omentum. *b.* Lesser peritoneal cavity containing abscess. *c, c.* Greater peritoneal cavity. *d.* Folds of great omentum. *e.* Small intestines. *f.* Liver. *g.* Cœliac axis. *h.* Duodenum. *i.* Transverse mesocolon. *j.* Mesentery. *k.* Pancreas.

the chances of recovery, as most of the patients become septic and develop complicating diseases at an early period. *Aspiration and incision* are the plans of treatment employed. Aspiration as a means of treatment needs only to be mentioned that it may be the more forcibly condemned, for the attempt to cure by this procedure is quite hopeless and should not be tried. Aspiration only for diagnostic purposes is admissible. Abdominal incision, or the thoracic incision with or without rib resection, can be practiced, according to the demands of the case.

The Abdominal Incision.—The abdominal incision is made at the epi-

gastric, hypochondriac, iliac, or lumbar region, as may suit best the demands
of safe approach to the abscess and the requirements of subsequent drain-
age. In any one of these incisions the technique of approach and entrance
to the abscess contemplates the steps preventing infection and the securing
of ample drainage, as in abscess elsewhere in the peritoneal cavity.

The Operation.—After proper aseptic care the incision is usually made
at the most prominent part of the tumor, or at the point best intended to
reach the pus, through the respective tissues down to the abscess. *If adhe-*
sions be present, the opening of the abscess and evacuation of its contents,
usually simple matters, should be carefully conducted. *If adhesions be not*
present, the serous membrane should be shut out of the operation field with
gauze tamponade before the ab-
scess is incised; and even when
properly performed subsequent
changes in the relation of the
parts, due to liberation of the pus,
movements of the patient, and the
natural disadvantages of pro-
longed drainage and its bad influ-
ence, expose the patient to mani-
fold dangers. In all anterior
incisions a more dependent drain-
age than the primary incision
offers should be established, if
possible. In the absence of abil-
ity to arrange this provision large
drainage tubes should be intro-
duced and the discharge facili-
tated by the position of the
patient when expedient. The

FIG. 1275.—Left-sided subphrenic abscess
containing gas.

accepted local treatment for abscess repair at other situations is prac-
ticed in these with such variation as circumstances may require. If the
abscess be accessible to the lumbar incision for exposure of the kidney, or to
the incision for removal of the appendix vermiformis, then, indeed, the
technique of approach and subsequent drainage differs from these opera-
tions in no essential regard. It is obvious at once that these are the most
satisfactory of all the abdominal incisions, and should be practiced when
feasible.

The Remarks.—Incision may be preceded by the use of the needle for
relaxation of the sac and for diagnostic purposes. In the instances of
abdominal incision, whether in the median line or at the costal border, free
dependent drainage should be secured through the loin the same as in
abscess of the lesser peritoneal cavity. It is much better to evacuate the
abscess through the pleural cavity by rib resection than to omit adequate
drainage in abdominal incision.

In abscess suitably located, incision in the loin only, affords ready access
to and good drainage of the pus. The incision parallel with and just below
the last rib is usually better than the vertical one for that purpose. Inci-

sions at the costal margin, followed by blunt dissection along the under surface of the diaphragm to the pus collection, are commendable in the treatment of abscess situated behind the liver and due to disease of the appendix, kidney, spleen, or other localizing cause.

The Thoracic Incision (Midaxillary Line).—The thoracic incision is commonly made across, but sometimes anteriorly to the midaxillary line. The technique is substantially similar in each instance.

The Operation.—After thorough aseptic care, place the patient on the back near to the side of the table; administer chloroform or ether as the indications suggest; *make an incision across the midaxillary line* three or four inches in length parallel with and down to the selected rib (eighth or ninth, possibly both); expose and resect the rib as in empyema (Fig. 1262); bare and puncture with a needle

Fig. 1276.—A thoracic opening in midaxillary line for subphrenic abscess, operative invasion of pleural cavity which is not closed by sewing. Pus seen on surface of liver.

the costal pleura for pus, and *if pus be present,* pack the borders of the wound with gauze to prevent pleuritic infection, and proceed with the evacuation. *If pus be not present,* and the pleural surfaces be not adherent, separate and raise the pleura from the diaphragm, holding it aside with gauze and seek for pus, or pack the wound and wait for adhesions, or, if
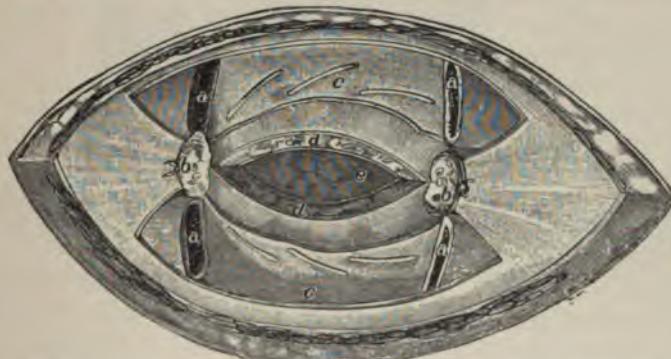
Fig. 1277.—The exposing of the upper surface of the liver and evacuating an abscess. *a, a, a, a.* Extremities of divided ribs. *b, b.* Intercostal tissues ligatured, divided, and removed. *c, c.* Costal and diaphragmatic pleura, sewed together with deep sutures. *d, d.* Two layers of pleura, the diaphragm and the peritonæum incised exposing. *e.* The liver.

permissible, unite the pleural surfaces with sutures and locate the pus with a needle (Fig. 1276).

Abscess at the convex surface of the liver can be exposed as follows: Make a transverse incision down upon the ribs, expose and resect one or

more of them, ligature and cut away the soft parts between the ribs, stitch together the costal and diaphragmatic pleura (Fig. 1277), shutting off the pleural cavity, locate the pus with a needle, incise the layers of pleura, the diaphragm, the diaphragmatic peritonæum, thus reaching the abscess and exposing the upper surface of the liver; liberate the pus by separating the tissues along the course of the needle with forceps or blunt scissors; interrupt the flow occasionally with a sponge to prevent unpleasant symptoms; introduce the finger or a spoon into the abscess and remove necrosed tissue if the condition of the patient will permit; arrest hæmorrhage, and cleanse the cavity with hot saline, or with the bichloride solutions if offensive;
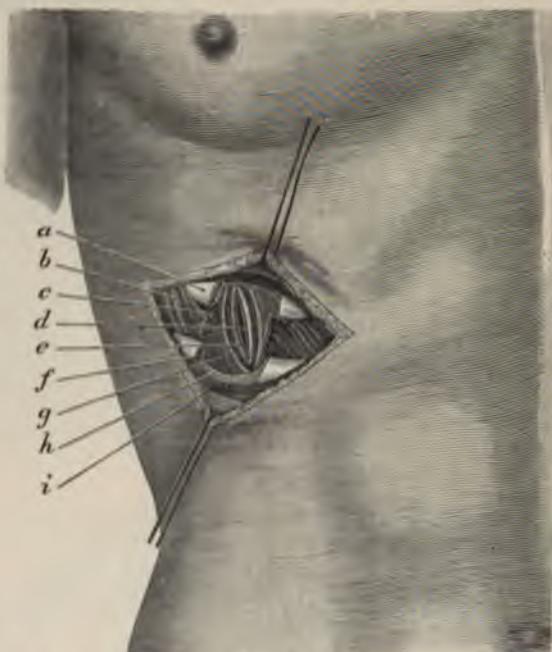
Fig. 1278.—Operation for exposure of subdiaphragmatic space and of liver anteriorly to the midaxillary line. *a.* Seventh rib. *b.* External intercostal muscle. *c.* Intercostal vessels and nerve. *d.* Liver. *e.* Peritonæum. *f.* Eighth rib. *g.* Diaphragm. *h.* Parietal pleura. *i.* External oblique muscle.

stitch the edges of the diaphragmatic opening to the skin if practicable; pack the abscess cavity lightly with gauze if it is small, introduce a three-quarters-of-an-inch drainage tube if it is capacious, introducing gauze lightly around it; cover with abundant gauze held in position with a binder, and cause the patient to lie on the affected side. Irrigation of the abscess cavity is avoided and the tube shortened to keep pace with its healing. *If excision be made anteriorly to the midaxillary line*, it is commonly located between the seventh and eighth ribs, portions of one or both of which may be removed.

The Operation.—Carry the incision obliquely forward between the ribs (Fig. 1278); expose and divide the external oblique muscle, detaching it

from the ribs; resect portions of one or more of the exposed ribs and the intervening soft parts, ligaturing the vessels at either end (Fig. 1278); expose and dissect off the thin intrathoracic fascia, uncovering the pleura; press together and unite with sutures the layers of pleura, if haste is required, if not, divide the outer layer and pack the wound to cause adhesions, and then later resume by dividing the inferior layer, thus revealing the diaphragm; observe that its fibers run downward and forward; separate and draw them apart, disclosing the parietal peritonæum as it rests on the convex surface of the liver. If the operation be for abscess or hydatid cyst of the liver, open with trocar, cautery, or knife at once if adhesions be present, if not, and time will permit, pack the wound and open two or three days later. If the case be urgent, sew together the parietal and visceral layers of peritonæum and open immediately, as before. If subphrenic abscess be the object of the operation, open into the abdomen at once; otherwise the methods are alike.

It is important to bear in mind that the technique of opening abscess of the liver (page 967 *et seq.*) is applicable to evacuation of subphrenic abscess similarly located.

If pus be present in the pleural cavity it is evacuated, and the subphrenic collection liberated and removed the same as before.

The Comments.—Pyothorax and subphrenic abscess are frequently associated, the former being a sequel to the latter. The proper seat of operation is established best by the aspirating needle, which is employed as well during the operation for the better localization of the pus. *Either the eighth, ninth, or tenth rib* is selected for incision, as a rule—the highest of the three in complicating empyema, the lowest in subphrenic abscess alone. In subphrenic abscess the lumbar and iliac routes are the best ones; the posterior and lateral thoracic are next in order; the anterior thoracic and abdominal are the most objectionable of all. The location of the origin and the extent of the abscess usually determine the availability of the respective routes.

The Results.—The earlier the diagnosis and prompter the treatment, the more favorable is the outcome of the case. Spontaneous healing is rare. The death rate is estimated from 50 (Maydl) to 82.5 per cent (Scheurlen).

Sachs reports 37.5 per cent die of operation. Early operation improves the rate 30 per cent.

Paracentesis Abdominis.—Paracentesis abdominis is an operation employed to remove fluids from the peritoneal cavity. It should be recognized at the outset that the procedure is not entirely devoid of danger. Aspirators and trocar and cannula are each employed for the purpose.

The abdominal wall should be thoroughly cleansed in advance of the operation, and be protected with gauze. The strength and fortitude of the patient to meet the requirements of the operation should be carefully estimated in advance, and the forces fortified with the necessary stimulants. The agent of puncture should be thoroughly smooth, sharp, and aseptic before introduction. The bladder and rectum should be empty, and the abnormal line of dullness of the abdomen carefully determined by percussion immediately before the puncture is made. The belly of the patient is

71

then surrounded by a broad, many-tailed bandage, having a small opening in the center corresponding to the point of proposed puncture. If unable to sit, the patient is caused to lie upon the side near to the edge of the bed. If the condition of the patient will permit, he may be placed in an ordinary chair with the body bent forward and the head and arms resting on the back of a chair placed in front. If a small rocking chair be employed for this purpose, the patient can be easily and quickly tipped backward into the recumbent position if syncope be imminent during the removal of the fluid. The injection of a weak solution of cocain at the seat of operation will meet the full anæsthetic demands of the act (Fig. 1279).

Fig. 1279.—Instruments employed in paracentesis abdominis, thoracentesis, tapping pericardium, etc.

a. Emmet's trocar. b. Rectal trocar. c. Duncan's trocar. d. Nest of trocars, assorted sizes. e. Common trocar. f. Fitch's aspirating protected pointed trocars, assorted sizes. g. Billroth's aspirating trocar. h. Aspirating syringes. Other forms of aspirators may be employed. Figs. 1281 and 1448.

The Operation.—Carefully localize the proper seat of puncture by percussion, and estimate the thickness of the abdominal wall; adjust the slit in the bandage to correspond to the point of introduction; seize the instrument firmly with the index finger so placed on the upper surface as to limit the extent of the introduction (Fig. 1280); push the instrument quickly into the abdomen and withdraw the trocar, leaving the cannula in place; tighten the bandage as the fluid escapes, to facilitate the flow and support the patient; remove the cannula as soon as the fluid has escaped, and when syncope is impending and further withdrawal at this time is impracticable;

close the puncture with an interrupted deep suture of catgut, and dress the part with gauze held in place with a bandage.

The Precautions.—Carefully avoid puncture of a distended bladder or uterus and of a displaced or enlarged viscus. If the puncture be made too near the line of dullness, or the instrument be misdirected, the intestines may be wounded. Carefully avoid puncture of the abdominal wall at the established site of significant blood-vessels. The plugging of the needle or cannula by fibrin is relieved by the introduction of a probe, causing dislodgment of the obstruction. As the fluid escapes, the intra-abdominal end of the instrument should be so changed in its direction from time to time

Fig. 1280.—The operation of paracentesis abdominis with trocar.

Fig. 1281.—Potain's aspirator.

as to avoid impingement on the intestines, especially if this extremity be pointed. Air should not be permitted to enter the abdominal cavity. The

fluid should be removed slowly to avoid needless danger of syncope, there-
fore the caliber of the instrument should not be large.

The Remarks.—Usually a slight incision of the skin is made at the seat
of puncture, but if the puncturing agent be sharp this step is not requisite.
It is not unwise to introduce a small needle at the outset, and perhaps with
a hypodermic syringe attachment, to more safely locate the fluid before
the larger instrument is plunged into the abdomen. Usually the puncture
is made in the median line midway between the navel and the pubes. If
the uterus be distended, the puncture can be made at either side through
the semilunar line or in the median aspect above the limit of distention, as
circumstances suggest. The many-tailed bandage is tightened as the fluid
escapes, and is confined in place, after the withdrawal, for three or four
days.

HERNIA OF THE ABDOMINAL WALL.

Abdominal hernia is a protrusion of a portion of the contents of the
abdomen through an opening in its wall, surrounded by more or less of the
tissues forming the wall. With but few exceptions herniæ possess a sac, and
this, in every case, is of the parietal peritonæum (Fig. 1282). Only those

FIG. 1282.—The sac of abdominal hernia.   FIG. 1283.—A sac, with intestinal contents.

viscera, such as the caput coli, colon, bladder, pancreas, etc., that are not
normally surrounded by peritonæum, can form hernia without a sac. The
contents of a hernial sac usually consist, either singly or conjointly, of
small intestine and omentum (Fig. 1301). The normal appearance of
the omentum and small intestine should be given a careful study, that
the surgeon may be able to determine the various degrees of change in
their appearance when subjected to the different influences associated with
hernial protrusion. The granular appearance of the omental fat, together
with its pale color and fibrous structure, will distinguish it from the sub-
serous tissue fat. The omentum and gut, while in the sac, usually bear
the same comparative relation to each other as in the abdominal cavity, the
former being in front. The sac has a neck and a body, the shape and size
of the latter depending upon the amount and density of the surrounding
tissues and the nature and compactness of the contents. The neck is the
constricted portion, and corresponds in size to the opening through which
it escapes, its dimensions being governed by the density of the tissues sur-
rounding it, the age of the protrusion, degree of traction, and compressibil-

ity of the contents. A knowledge of the normal characteristics of the peritonæum is essential. Its rough outer and smooth inner surface, the peculiar arrangement of its vessels and its transparency, should be understood. It must not be forgotten, however, that the physical appearance of the sac and contents become changed when long subjected to the vicissitudes attending hernial protrusions.

The tissues composing the wall of the protrusion, called the " coverings of hernia," vary according to the situation, the direction, rapidity of development, and size of the hernia. While these tissues may readily be distinguished as component parts of a normal abdominal wall, yet, when covering the body of a hernia and more or less changed from the effects of pressure and extraneous influences, they often become difficult of recognition.

In a recent hernia the cellular tissues and fat vary but little in appearance from the normal condition; in an old hernia these tissues are much thinner than in the former. In a recent protrusion the muscular fibers of the cremaster are exceedingly sparse and ill developed, while in the older ones the influence of traction leads to a marked development of them, which is of great diagnostic importance, as bearing on the progressive depth of the operation incision and the variety of the protrusion. The normally transparent sac often becomes more or less opaque, and scarcely distinguishable from the tissue lying upon it.

It can be properly said that the changes in the appearance and the anatomical relations of the component parts of a hernia may be so manifold that it will often present as varied and perplexing problems for a speedy solution as any other morbid condition of the body.

The operations applicable to the cure of the various abdominal herniæ are: For strangulated hernia, taxis and division of the constriction; for the reducible hernia, the operation for radical cure; for simple irreducible and obstructed forms of hernia, the liberation of the contents and their return to the proper situation and retention by radical methods.

Strangulated Hernia.—In strangulated hernia a constriction located at the neck or within the sac itself causes obstruction of the circulation entirely or in part, thereby exposing the affected portions to the danger of gangrene. The operations for relief of strangulation are *taxis* and *herniotomy,* the latter sometimes being called kelotomy, and in common parlance " an operation for strangulated hernia."

Taxis.—Taxis consists in returning the strangulated viscus by manipulation through the channel of escape, aided by force of gravity and relaxation of the constricting agencies, to the abdominal cavity. As a rule, strangulation occurs in protrusions of long standing, where the patient is self-educated in the practice of reduction. It therefore follows, when the case is brought to the attention of the surgeon, that the patient has made persistent but ineffectual efforts to reduce it. Under these circumstances the outlook for the surgeon's success at reduction is not brilliant. He should determine, first, the variety of the hernia, so that his efforts may be intelligently directed; also its condition, that the efforts may not injure the parts or lead to harmful procrastination. If moderate attempt is not sufficient

to reduce a strangulated hernia, a hypodermic injection of morphin may be given at once near the seat of the constriction, and the patient put in a warm bath, with the pelvis elevated, and kept there until the combined influences of these measures are felt on the general system. Thus the protrusion can often be returned without serious difficulty by either the patient or surgeon, the former being less liable to employ harmful force because of

the pain produced. If these measures fail, an anæsthetic should be given, with the understanding that a failure at reduction then will be followed by an immediate operation.

Taxis is practiced by relaxing the tissues contributing to the constriction, and endeavoring to return the part of the hernia first which escaped last, in the direction of the channel through which it appeared. For this purpose empty the bowels and bladder, raise the pelvis, flex
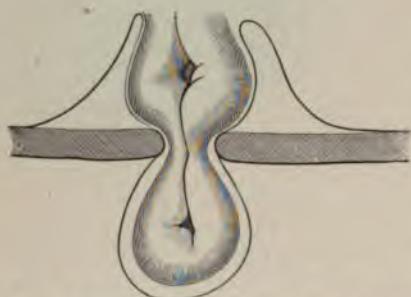
FIG. 1284.—Strangulated hernia and sac, awaiting reduction by taxis.

the thighs upon the body and so abduct and rotate them as to properly relax the tissues about the groin and abdomen, grasp the tumor with the right hand, and draw it downward carefully to disengage its neck and at the same time to give to it the proper direction for reduction. Gentle, uniform, and continuous pressure is then made upon it with the right hand, while the thumb and fingers of the left steady its upper extremity.

The Precautions.—The sac and contents (Fig. 1284) may be bruised or ruptured from too frequent or forcible manipulation. The protrusion may be reduced *en masse* (Figs. 1285 and 1286), followed by the continuation or recurrence of the symptoms of strangulation. Incision at the seat of strangulation or in the median line of the abdomen offers the only chance of relief in this condition. Taxis should not be practiced if the hernia has

FIG. 1285.—Strangulated hernia, indirect reduction *en masse*.

FIG. 1286.—Strangulated hernia, direct reduction *en masse*.

been irreducible; if symptoms of inflammation, gangrene, or general peritonitis be present; and if the strangulation be of long standing—twenty-four hours—and have been frequently subjected to manipulative attempts.

If taxis is to be successful, after a brief trial the surgeon will be conscious of a slight gurgling noise, followed by a diminution in the size and tension of the tumor caused by the escape into the bowel above of gas or

fæcal matter, which will soon be followed by the return of the entire protrusion. In omental hernia the gurgle will be absent for obvious reasons. Properly directed taxis should not be continued longer than five or ten minutes, and if improperly directed, the sooner stopped the better.

In taxis for the relief of a complete femoral protrusion, it must not be forgotten that it is first necessary to *press downward, and then backward and upward*. It not infrequently happens that a large high femoral hernia is mistaken for an inguinal, and therefore the efforts at reduction are directed to returning it through the inguinal canal, a manifestly impossible and unfortunate proposition.

The Results.—All cases of strangulation die if unrelieved. Taxis gives a death rate of 5.8 per cent in inguinal and about 15 per cent in femoral herniæ. Early and discreet effort will lessen the rate.

Herniotomy.—The steps of the operation of herniotomy may be logically divided into six: 1, preparation of the patient and division of the tissues; 2, recognition of the sac; 3, opening of the sac; 4, examination of the contents; 5, division of the stricture and return of the protrusion; 6, closure of the wound.

The Preparation of the Patient and Division of the Tissues.—After the parts are shaved and cleansed by scrubbing, and suitably placed in a good light, and the patient etherized, an incision two or three inches in length is made through the integument, by transfixion, or direct division in the long axis of the tumor. The remaining structures, forming the wall of the sac, are often picked up one after another with the thumb forceps at the lower angle of the wound and nicked, the grooved director is pushed beneath each one successively, which is then divided with the scalpel or scissors. Freehand division of the tissues without the use of the grooved director is proper practice for those whose knowledge of anatomy and whose educated sense of touch will warrant it; but the less experienced will find that more personal comfort and better results will follow the wise employment of the director than the adoption of the ways of the more experienced. The possibility of recognizing the different layers of hernia will depend very largely on the length of time the hernia has existed, as well as upon the amount of external irritation to which it has been subjected. It is exceptional, however, when the muscular layers and the deep fascia can not be easily recognized. The sac is recognized by its relation to the various overlying tissue planes of special significance; the fascia transversalis, which covers and is separated from it by the fatty subserous tissue, is quite liable at first to be mistaken for the peritonæum. This fascia is dense, opaque, non-translucent, and always present. If in the course of operation a similar tissue has not yet been divided, this one can not be the sac. A minute opening should be made through it at the lower portion of the wound, a grooved director passed beneath it, and its division carefully made. The next layer is the subserous fat, which is often quite well marked. If the surgeon divides the fascia transversalis under the impression that it is the sac, he will then mistake the subserous fat for omentum in the protrusion. This fallacy will be quickly dispelled, however, when he attempts to find the intestine, or to return the supposititious omentum to the abdominal cavity.

The Recognition of the Sac.—The sac is globular in form, of a bluish color, tense, and often transparent. A sense of fluctuation is frequently dis-
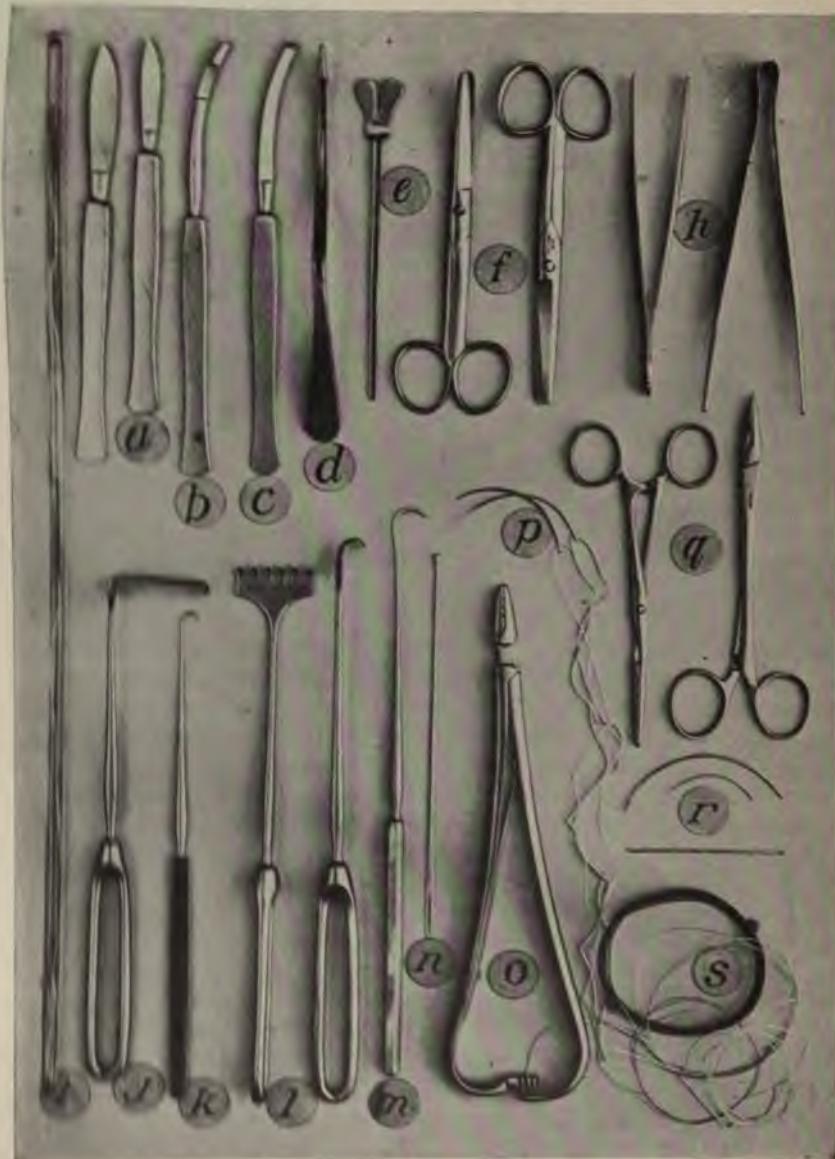
Fig. 1287.—Instruments employed in herniotomy.

a. Large and small scalpel. *b.* Hernia bistoury. *c.* Curved, probe-pointed bistoury. *d.* Hernia director. *e.* Common director. *f.* Curved and straight scissors. *h.* Dissecting and mouse-tooth forceps. *i.* Kangaroo tendon in glass tube. *j, l.* Blunt and hooked retractors. *k, m.* Tenaculum and blunt hook. *n.* Silver probe. *o.* Needle holder. *p.* Traction loops. *q.* Small clamp and small needle carrier. *r.* Curved and straight needles. *s.* Chromicized catgut and silkworm gut. Good light is very important.

cernible at its lower portion. When not too tense with fluid it can be pinched up between the thumb and finger, and its smooth serous surfaces can be rubbed together, if they be not adherent to the contents. This manifestation is diagnostic. Before the sac is opened, the intestine may be pinched up in the same manner, but it will quickly and easily escape the grasp because of the smooth apposed serous surfaces. If a small hollow needle be introduced, a drop of fluid will escape; this is a characteristic of a hernial sac.

Finally, if the membrane be examined it will be found to surround and limit the protrusion, being movable only as a whole, to be denser than the intestine, and devoid of an external serous surface. The sac is picked up with the thumb forceps at the fluctuating point where the drop of fluid escaped, and a small slit is made in it with the knife point held at right angles to the forceps (Fig. 1288). If

Fig. 1288.—The operation of herniotomy. Nicking hernial sac.

fluid be present it will then escape. A grooved director is inserted, and an opening made of sufficient size to admit the index finger, which is introduced to determine with certainty the tissue just cut, and also the location of the constriction. If the finger be in the sac, it will come in contact with smooth surfaces on all sides, and, after division of the constriction, it can be passed through the neck of the sac into the abdomen. If the finger be outside the sac serous surfaces will be absent, and the finger can not be passed upward. The existence of cyst constrictions of the sac (Fig. 1289), or a double sac (Fig. 1290), in the line of incision may confuse the surgeon; however, if the finger be introduced into them in turn, their non-serous lin-

Fig. 1289.—Cystic construction of hernial sac.

Fig. 1290.—A double hernial sac.

ing and the limited extent of each variety will expose the fallacy. The sac is opened sufficiently to expose its contents to a careful scrutiny in order that their condition may be carefully considered.

The Examination of the Contents.—Unless contraindicated, the constricted point should be divided at once after exposure of the contents of

the sac, in order to relieve the strangulation and thus enable the surgeon to estimate its influence on the integrity of the gut. Under all circumstances there will be more or less injection of the vessels in strangulation. If the constriction be recent or slight, the changes in the imprisoned tissues will not be great; but when severe, or long continued, or where there has been much handling, the intestine will be more or less purple or blackish, perhaps with isolated ecchymoses and bathed in bloody fluid. The color of the bowel is not of as much importance in determining the presence of gangrene as the inability to restore the circulation after division of the stricture by the aid of warm fomentations. If the bowel be pricked or slightly scarified and no blood flows; if the circulation be absent and the part becomes cool; if its luster be destroyed and its structure be softened and crackling, it should not be returned. If to all these be added the odor of gangrene, with the presence of a slough, the intestine should be opened to afford exit to its contents and treated with warm fluid aseptic applications. It is good prac-

FIG. 1291.—The operation of herniotomy, passing knife along finger.
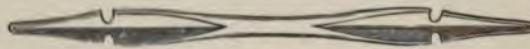
FIG. 1292.—Levis's hernia director.

tice to excise at once a circular portion of the intestine corresponding to the gangrenous part and unite the extremities, as described under the head of enterectomy (page 804), if the state of the patient will permit. If the omentum be gangrenous or bulky, ligature it near the mouth of the sac and cut it off; if not, it can be returned. If the contents of the sac be adherent to each other or to the sac, the adhesions may be ruptured if of recent date. It is often necessary, however, to sever them with the knife or scissors, and in doing so the vessels should be ligatured with fine catgut as soon as seen. When the adhesions are very firm and limited, as much of the adherent parts is dissected off as practicable and the remainder returned with the bowel.

FIG. 1293.—The operation of herniotomy, passing knife along director.

The Division of the Stricture.—The constriction may be divided from

without or from within the sac, the latter being the more frequent site selected. If from without, it may be divided before or after the sac is opened. The former plan is the common practice. If the hernia be small, and strangulation have lasted but a few hours without severe symptoms, and be composed of intestine alone, the constriction may be divided and contents reduced without opening the sac. However, it is much wiser under all circumstances to open the sac and thus be assured of the integrity of the bowel. In division of the constriction within the sac, the finger is carried up to the point of the obstruction, followed quickly by a director (Fig. 1287, *d, e*), or a hernia bistoury or probe-pointed bistoury (*b, c*) carried along the finger (Fig. 1291). Division of the constriction can be readily done by passing beneath the constricting tissues the hernia director of Levis (Fig. 1292), which is cautiously carried upward until the constricting band falls into the notches at either

FIG. 1294.—Apparatus for washing out the stomach.

side of the groove; a probe-pointed bistoury or the ordinary hernia knife is then carried along the groove, and the stricture divided (Fig. 1293), *not freely*, but only sufficiently *nicked* to permit the return of the intestine. In dividing the constriction the edge of the knife should be directed away from important vessels. If the gut be gangrenous, great caution must be observed in cutting the band, or the adhesions of the bowel to the border of the opening may give way and allow the gut to

FIG. 1295.—Washing out the stomach; introduction of the fluid.

FIG. 1296.—Washing out the stomach; siphoning out the fluid.

escape into the abdominal cavity. If extended gangrene be assured and immediate repair be impracticable, it is better not to divide the constriction, thus exposing the patient to the danger of the return of the gan-

grenous bowel into the abdominal cavity, and also to the entrance of dis-
charges from the wound. Instead open the bowel so as to relieve the
obstruction, otherwise allow it to remain undisturbed.

The General Remarks.—The field of operation should be scrubbed and
shaved widely, the bladder emptied, the stomach washed out thoroughly,
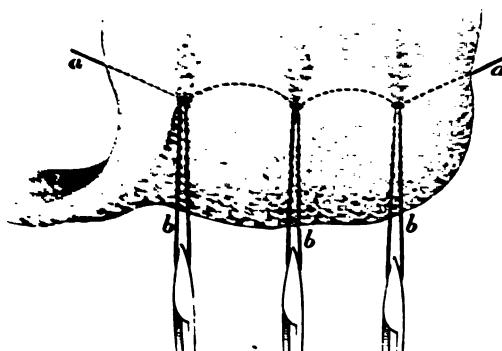
Fig. 1297. Tying off omentum. *a, a.* Ligature drawn through omentum in loops,
b, b, b.

especially *if fæcal vomiting* has occurred (Fig. 1294). In fact, lavage is
often very serviceable in the event of vomiting from any obstructive cause,
as it soothes the stomach, lessens the nausea and vomiting, and thus obviates
the abdominal strain. The patient can quite easily be taught to swallow
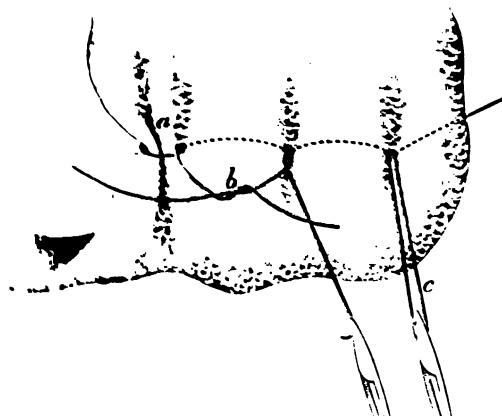
Fig. 1298. Tying off omentum. *a.* Section ligatured. *b.* Ligature being tied. *c.* Loop
for ligaturing.

the tube (page 393, vol. i) often without the aid of the finger—and to
promote well lavage by repeatedly changing the altitude of the funnel (Figs.
1304 and 1306).

A blue hernial sac may be mistaken for the gut, and attempts at reduc-

tion be persistently made. The sacs of old herniæ in thin people, umbilical and congenital herniæ in all, and the herniæ subjected to long pressure, are thin and often so near to the surface that caution is essential to avoid injury of the gut, especially if adhesion of it to the wall of the sac be present. The fluid in the sac varies in character according to the condition of the contents. Bloody fluid indicates either great degree of constriction or violent or excessive manipulation (taxis) ; dark and offensive fluid indicates tissue degeneration, gangrene, and perhaps rupture of the gut. The dilatation of the constriction by forcing the finger through it in the presence of the gut should never be attempted, since the gut is bruised by the act. The return of the gut to the abdominal cavity requires care and patience. The mesentery should precede the gut, as a rule. The reduction first of the part that came down last applies to reduction after as well as before operation. Raising the pelvis or foot of the bed facilitates the return. The drawing apart of the opening with hooks, catching the borders of the sac with forcipressure and raising them up in a funnel shape aid the return. Other serviceable manœuvres will occur to the surgeon at the time. The omentum is usually removed after ligaturing it in small masses, and the stump returned entirely into the abdominal cavity (Figs. 1297 and

FIG. 1299.—A strangulated short loop of intestine.

FIG. 1300.—A strangulated portion of wall of intestine.

1298). The leaving of omentum in the canal is objectionable, as it predisposes to volvulus and contributes to the return of hernia. If the gut be much discolored and of doubtful vitality, divide the constriction, withdraw the gut from its grasp and allow it to remain outside surrounded with warm, moist, aseptic dressings. The amount of strangulated intestine depends largely on the extent of the protrusion. A short loop (Fig. 1299) or only a portion of the wall (Fig. 1300) of the gut may be thus involved. If only a small circumscribed spot be suspected, it may be returned just inside of the abdomen and a large drainage tube introduced into the inner end of the canal, with the idea that the chances of final recovery of both gut and patient are improved by the latter plan. At all events, such seems to be the case. If the patient be kept quiet the relation of the part to the internal ring will change but little, if at all. But, in the face of vomiting and other physical manifestations that disturb the relations of the intestines, the suspected part might readily become removed so far from the opening and the tube as to cause a general peritonitis in case of sloughing, instead of circumscribed adhesion and discharge through the tube as provided for. If gangrene be present, and the patient's condition and the surgeon's preparation will warrant, enterectomy should be practiced as already described (page 804), and by the method best suited to meet all the demands of the

occasion. If enterectomy be not advisable, the constriction may be divided
or not, as best suits the views of the surgeon. If it be divided and the gut
be drawn down and stitched in place, the peritoneal cavity may become
infected at once or later. If the constriction and gut be not disturbed,
and the bowel be so incised as to allow the escape of its contents, little
danger of infection can arise at any time. The latter is surely the safer
procedure and offers no subsequent disadvantage. In gangrenous intestine
primary resection gives a death rate of from 47 (Mikulicz) to 50 per cent
(McCosh), which is about 25 per cent less than when treated by
artificial anus.

The After-treatment.—As soon as the bowel is returned, stop all hæmor-
rhage, unite the wound with catgut carried through the sac, introduce a
drainage tube, apply a compress, dress antiseptically, raise the foot of the
bed, and quiet the patient with an opiate. If the condition of the patient
will approve, a radical cure should follow at once after reduction of the con-
tents of the sac.

Strangulated Inguinal Hernia.—A hernia in this situation may be
direct or indirect, either of which may be complete or incomplete. In the
indirect or oblique form (Figs. 1301 and 1302) a complete hernia enters
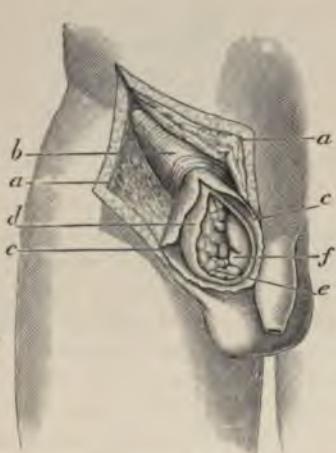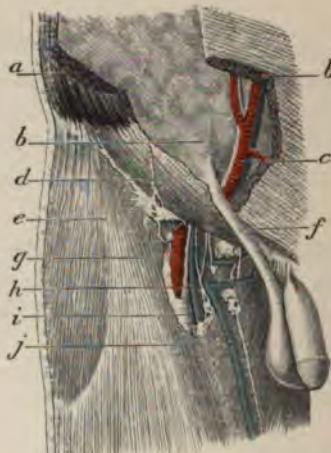
FIG. 1301.   FIG. 1302.

FIG. 1301.—Indirect or oblique inguinal hernia, omentum and intestinal contents. *a, a.*
Integument and superficial fascia. *b.* Aponeurosis of external oblique muscle. *c, c.*
Fascia transversalis. *d.* Sac of hernia. *e.* Omentum. *f.* Intestine.

FIG. 1302.—The anatomy of inguinal and femoral regions, showing course of descent of
indirect or oblique inguinal hernia. *a.* Divided borders of abdominal muscles. *b, b.*
Transversalis fascia. *c.* Deep epigastric vessels. *d.* Aponeurosis of external oblique
muscle. *e.* Fascia lata. *f.* Spermatic cord. *g.* Femoral artery. *h.* Femoral vein.
i. Sheath of femoral vessels. *j.* Saphenous vein.

at the internal abdominal ring, and passes downward and forward in the
canal through the external ring. The constricting agent external to the
sac may be located at either the internal or external abdominal rings, and

rarely in the inguinal canal. The cutting down upon the sac, and detecting and dividing the constriction, is described sufficiently under the general considerations. If the seat of the constriction be at the internal ring it should be divided upward and outward to avoid the epigastric artery (Fig. 1302, c) which runs along its inner border (Fig. 1303). In fact, in the
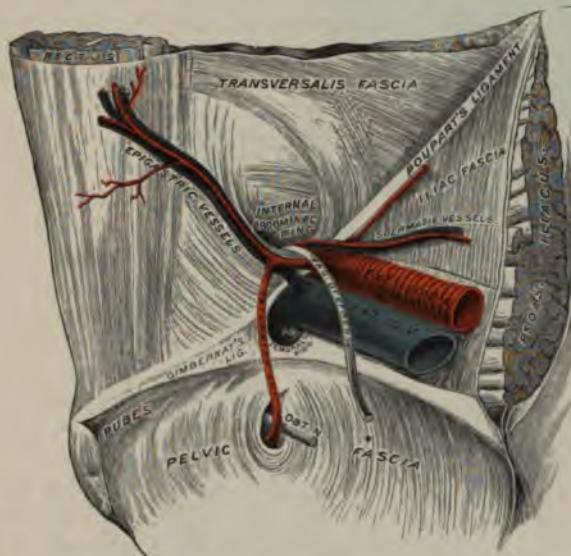
FIG. 1303.—The course of deep epigastric and obturator vessels.

oblique variety the incision upward and outward is always to be made irrespective of the situation of the constriction. *The only fallacy* that may arise is that of mistaking the direct for the indirect form of hernia. In recent and in congenital cases this mistake can hardly occur, but in those of longer standing, especially in acquired oblique hernia, the traction upon tissues of the ring at the neck of the sac drags the ring inward in front of the point of exit of the direct variety, and hence it is quite difficult and often impossible to distinguish between them. If the neck of an oblique hernial sac be dragged inward, the epigastric vessels are pressed directly against its inner aspect, and also encroach upon its upper and lower borders. Under these conditions, if the stricture be divided agreeably to directions often given—parallel with the course of the epigastric vessels—or even upward or slightly outward, these vessels will be in danger of injury.

If, on the other hand, the protrusion be of the direct variety, and the incision be made upward and outward, under the impression that it is a displaced indirect form of hernia, the epigastric vessels will then be exposed to peril (Fig. 1304). It is readily seen, therefore, that great caution should be employed in distinguishing between the two prior to cutting the constriction. It is practically impossible to discriminate between them until the coverings of the sac are examined. The oblique variety has for a covering the cremaster muscle, which can readily be distinguished in an

old hernia. This muscle never forms the covering of a direct hernia *except* when it passes to the outer side of the conjoined tendon, when its coverings are similar to those of the oblique form. It therefore follows, from the

FIG. 1304.—Direct inguinal hernia. *a.* Integument and fascia. *b.* Aponeurosis of external oblique muscle. *c.* Fascia. *d.* Spermatic cord. *e.* Epigastric vessels. *f.* Sac. *g.* Hernial contents.

anatomical relations, that when the cremaster does not form a covering the constriction should be divided upward and inward—that is, away from the epigastric vessels. If the cremaster forms one of the coverings, then the constriction must be cut upward and outward, provided there be no evidence that it is a direct hernia which has escaped to the outer side of the conjoined tendon. This latter condition is fortunately rare, and this, when taken in connection with the location of the tumor at its incipiency, should settle the question between the two. If, however, it be impracticable to settle the doubt, dull the edge of the knife by drawing it across a piece of metal, and then proceed carefully to nick the neck of the constriction in an upward direction. If the constriction be at the external abdominal ring, it matters little in which direction the cut is made; however, to simplify matters, the direction upward and outward should still be adhered to. The methods of examination of the contents of the sac and their reduction, together with the subsequent treatment, are sufficiently considered in the preceding pages. If the protrusion be incomplete the treatment is similar, and the matter simplified by the inability to confound the direct with the indirect varieties of this form.
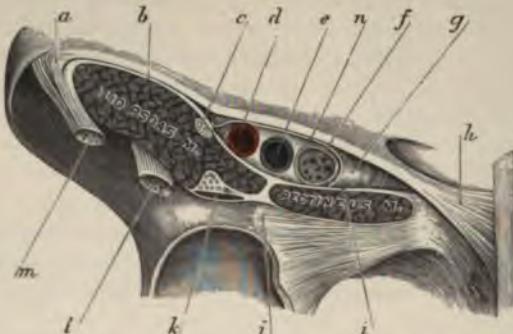
FIG. 1305.—Transverse section below Poupart's ligament. *a.* Anterior superior spine of the ilium. *b.* Iliac fascia. *c.* Anterior crural curve. *d.* Femoral artery. *e.* Femoral vein. *f.* Septum crurale. *g.* Gimbernat's ligament. *h.* Spine of pubes. *i.* Pectineal fascia. *j.* Ilio-pectineal eminence. *k.* Iliac bursa. *l.* Rectus femoris muscle. *m.* Sartorius muscle. *n.* Transversalis fascia.

The Results.—The general rate of mortality of operation for strangulated inguinal hernia is about 14 per cent.

Strangulated Femoral Hernia.—The protrusion in this instance enters at the femoral or crural ring at the inner side of the femoral vein (Fig. 1305), passing between the vein and Gimbernat's ligament; and the inner boundary of the femoral canal for about half an inch, to the upper portion of the saphenous opening (Figs. 1306 and 1307), through which it escapes; afterward, in many instances, it passes upward and rests upon the falciform process of that opening (Fig. 1308). The *two common points of constriction* are Gimbernat's ligament (Fig. 1305) and the sharp border of the fal-
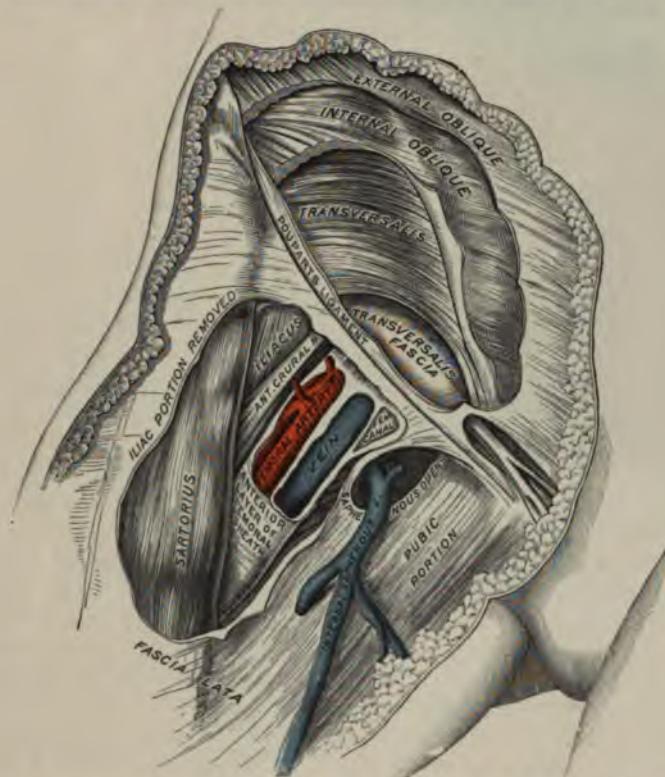
Fig. 1306.—Anatomy of the femoral region, showing through opening in femoral sheath the relations of the femoral canal to the femoral vein and saphenous opening.

ciform process of the saphenous opening. The important boundaries of the upper extremity of the crural canal are, within, Gimbernat's ligament, and without, the femoral vein (Fig. 1305), surrounded by its sheath. Throughout the course of this canal the femoral vein lies at the outer side. The distinctive coverings of this protrusion are the cribriform fascia, crural sheath, and septum crurale. The important vascular relations are those of the femoral vein and the obturator artery.

Taxis should be employed with greater caution and for a shorter time in femoral than in inguinal hernia, since the constricting influences are greater, and the neck of the sac much smaller in the former. The fact

75

is again referred to that a femoral hernia that extends upward toward Poupart's ligament, sometimes reaching above it, may be mistaken for one of the inguinal variety; and therefore the efforts at reduction are directed to returning it through the external abdominal ring instead of pushing it downward, backward, and upward, as is necessary to effect a reduction of the former.

The Operation.—The field of operation should be washed, shaved, and disinfected; the patient placed on the back, the thigh flexed and rotated outward, the bladder emptied, the patient anæsthetized, and a vertical incision made upon the tumor in the line of the long axis of the femoral canal, with the center over the border of the falciform process (Fig. 1308). The integument and superficial fascia should be carefully divided, thus exposing the *cribriform fascia*, which in fleshy subjects is loaded with fat. This fascia and the glands connected with it (Fig. 1308), especially if the latter be enlarged, form a mass often difficult to understand. The glands should be pushed aside and the remainder of the structure carefully divided. It can hardly be mistaken for anything but the omentum, or the deeper layer of fatty tissues. The absence of the sac will readily expose the former fallacy, and the presence of the latter will soon be disclosed. The *femoral* or *crural sheath* comes next in order (Fig.
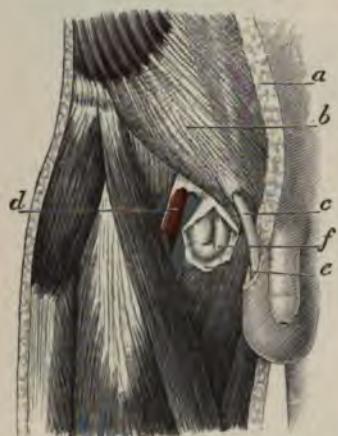
Fig. 1307.—Complete femoral hernia. *a.* Integument and fascia. *b.* Aponeurosis of external oblique muscle. *c.* Spermatic cord. *d.* Femoral vessels. *e.* Sac of hernia. *f.* Intestinal contents of hernia.

1306). It is dense, like the fascia transversalis, of which it is a prolongation, and might be mistaken for the sac did it not present appearances of a different character, which have already been described. The *septum crurale* (Fig. 1305) will hardly form one of the entire coverings if the protrusion be large; if it does form a covering it will be much diminished in thickness, and somewhat blended with the subserous tissue. It sometimes happens that the small lymphatic gland, which normally exists between the subserous tissue and the septum crurale, can be distinguished, which, of course, settles all doubts as to the identity of the tissues under inspection. The careful use of the knife and director soon exposes the sac with its characteristic appearance. It should be opened at the lower extremity with the precautions previously enjoined and the stricture sought for and divided. If the stricture be, as is usual, at the free border of the falciform process, flex the thigh, rotate it inward, and if no further obstruction exists, the protrusion can be reduced. If the constriction be at the free border of Gimbernat's ligament, this, too, must be nicked. It is necessary to recall, before the nicking, that the obturator artery once in three and a half cases arises from the epigastric, and although it usually lies in contact with the vein in its

descent (Fig. 1309), and is therefore out of danger, yet it not infrequently curves inward along the free margin of Gimbernat's ligament (Fig. 1303), thus nearly encircling the neck of the sac, and therefore is in great danger of being cut. The knife should be made quite dull, and the ligament nicked superficially and obliquely upward and inward in this instance. The tip of the little finger may then perhaps safely be inserted and the artery sought for along the posterior surface of the ligament; if not discovered, the nicking may be repeated, or firm traction with the finger against the ligament may be made, aided perhaps by a hook, so as to tear or stretch it. This ves-
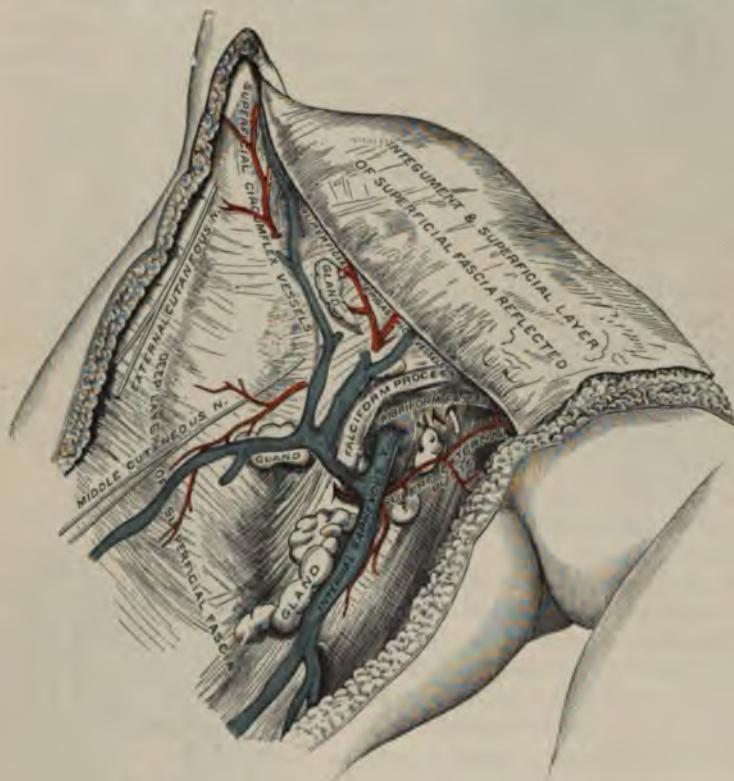
Fig. 1308.—Superficial anatomy of femoral region.

sel may have been cut ten or twelve times in this operation, but in each instance the bleeding was controlled by ligature or compression, and the patient recovered. After returning the protrusion the wound is closed and dressed antiseptically.

Femoral herniæ do not always follow the course just described; they take, though infrequently, anomalous courses, sometimes appearing at the outer side, or behind the femoral vessels. They have been known to pass through Gimbernat's ligament. It is important to know that in all the anomalous cases the neck of the sac lies closely associated with the epi-

gastric artery alone, or together with the obturator, and troublesome and even fatal hæmorrhages may be caused unless care is taken in dividing the constriction.

FIG. 1309.—The curve of the obturator artery and consequent relation to Gimbernat's ligament (*).

The Results.—The general death rate after operation for strangulated femoral hernia is about 19 per cent.

Strangulated Umbilical Hernia.—Umbilical herniæ appear at all ages of life and in response to devious causes. The symptoms of strangulation are generally acute, although large, old, and persistent protrusions of this kind sometimes do not cause pronounced manifestations.

The Operation. — After thorough cleansing of the surface, make an elliptical incision at the median line broad enough to include the superabundant tissue; deepen the incision at one side down to the aponeurotic structure; reflect this half of the ellipse toward the median line, thus exposing the neck of the sac and the margin of the hernial opening at that side; repeat the step at the opposite side, thereby isolating the hernial opening, the neck and body of the sac, the latter still bearing the integumentary ellipse; open the sac at the point farthest from adhesions and at the lower border, if practicable; expose and examine the contents; remove omentum (Figs. 1297 and 1298), retain and repair gangrenous intestine, enlarge the hernial orifice above and below and return the sound parts to the belly; sever the neck of the sac at the border of the hernial opening and remove the sac with the integumentary ellipse; freshen the border of the hernial opening and close it directly by sewing or after the method of radical cure (page 1161); dress the wound, put the patient in bed on the back for three or four weeks. A supporting pad is worn for months after resuming the erect posture. If the condition of the patient will permit, a radical cure should be practiced at once. The constriction should be divided without the sac when feasible, but the contents ought not to be returned until examined through an incision made into the sac.

FIG. 1310.—The relation of an obturator hernia to the obturator membrane and vessels, and to the bone.

The Precautions.—Taxis in strangulated umbilical hernia should be practiced with especial care, to avoid injury of the contents of the sac. If the intestine be gangrenous, the constriction causing it should not be divided

unless repair of the gut is made at once, because infection of the peritoneal cavity is almost sure to follow on account of the relations of the wound to the dorsal position of the patient.

The Results.—A general death rate of about 35 per cent follows operations for strangulation. If prompt action be taken a much better outlook than this may be expected.

Strangulated Obturator Hernia (Fig. 1310).—The viscus in this instance follows the course of the obturator vessels in its escape from the pelvis, and lies beneath the pectineus and obturator muscles. It is usually small and may not be detected during life.

The incision for its relief is made over the tumor at the inner side of and parallel to the femoral vessels. *The constriction* has been found in the fibers of the pectineus muscle; and it is usually necessary to divide some fibers of this muscle in order to expose the opening through which

Fig. 1311.—A lumbar hernia escaping through the canal of Petit.

Fig. 1312.—A large ischiatic hernia.

the bowel has escaped. The relation of the obturator vessels to the neck of the sac varies, being equally frequent at the outer and inner sides, never in front, but occasionally behind it. If the constriction be found at the foramen, it will require much caution to divide it without implicating these vessels. Abdominal section has been practiced in many instances of relief.

The Results.—The death rate is about 50 per cent with surgical treatment, owing, no doubt, to delay in detection and diagnosis.

Strangulated ventral hernia is treated not unlike that of umbilical. Strangulated lumbar (Fig. 1311), ischiatic (Figs. 1312 and 1313), perineal, and diaphragmatic herniæ (page 1276) are especially dangerous because of failure of recognition, if at all, until too late for operative benefit. In ventral 50 per cent die.

Retroperitoneal Hernia.—This variety of hernia is rarely determined except when revealed by cœliotomy for the relief of intestinal obstruction due to strangulation. The fossa duodeno-jejunalis of Treitz (Fig. 1102),
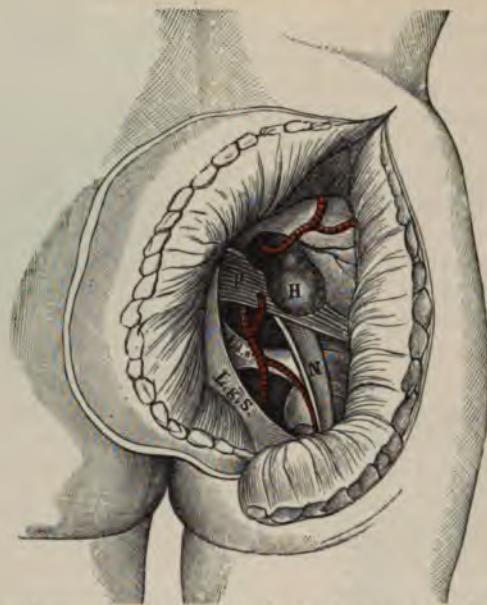
FIG. 1313.—The contiguous anatomy of ischiatic hernia. *H*. The hernia. *P*. Pyriformis muscle. *N*. Great sciatic nerve. *L. g. s.* Great sacro-sciatic ligament. *L. l. s.* Lesser sacro-sciatic ligament. The gluteal nerve and vessels are seen above the hernia, and the sciatic below.

the subcæcal fossa of the inner side of the cæcum, the foramen of Winslow and the fossa intersigmoidalis and at the under surface of the mesocolon sigmoid flexure, are the most frequent sites of this form of hernia, and occur in the order stated. These herniæ may be small or large, the contents even comprising nearly the whole of the small intestine (Fig. 1314). The constriction is relieved and the point of escape enlarged sufficiently to permit of the withdrawal and proper replacement of the intestines. The technique referable to operations of the peritoneal cavity, hernial protrusions, and repair of the peritonæum, will meet the requirements of these cases.

FIG. 1314.—Retroperitoneal hernia of the small intestine. *h.* Sac of hernia. *j.* Protruding loop of jejunum. *i.* Ileum. *c, c, c, c.* Ascending and transverse colon. *f. s.* Sigmoid flexure. *o, o.* Omentum.

Sixty-four duodenal, 12 pericardial, 8 of the foramen of Winslow, and 3 intersigmoidal herniæ have been collated by Jonnesco.

The Operations for the Radical Cure of Hernia.—Various operative methods have been devised for the cure of hernia, the majority of which have not withstood the test of time and the ever-increasing simplicity of operative technique. The operation for radical cure of hernia should be practiced with much discretion, as all persons thus affected are not proper subjects, nor are all herniæ suitable ones for operation. Elderly persons with large herniæ, and

infirm ones with hernial protrusions that can be retained in place, should not be subjected to operation except for strenuous reasons, and then only after they are made aware of the danger which the procedure invites. The young and vigorous are the proper subjects for this treatment. Primary union without annoyance from buried sutures thereafter are the local desiderata of greatest importance. Therefore, rigid asepsis is to be employed when possible. Kangaroo tendon is the most reliable absorbable, and silver wire the best unabsorbable, suture, now in use. Silken sutures are very serviceable indeed when thoroughly aseptic. Silkworm gut and catgut should be discarded for this purpose.

Bassini's Method of Operation (*Inguinal Hernia*).—Bassini's method is comparatively simple and thoroughly efficient, and is practiced oftener at the present time in this country than any other method.

The Operation.—Make an oblique incision half an inch above and parallel with Poupart's ligament from a point opposite the anterior superior
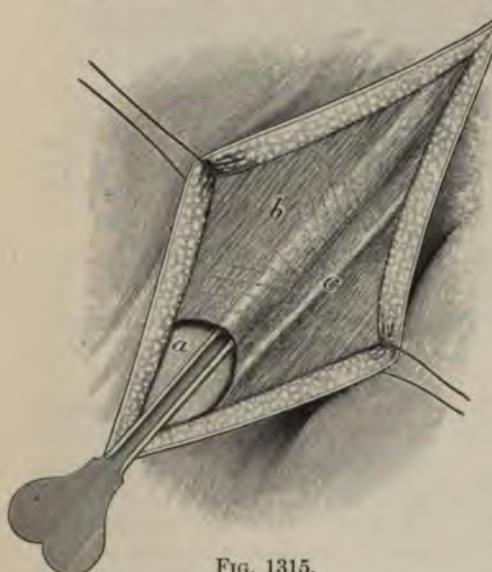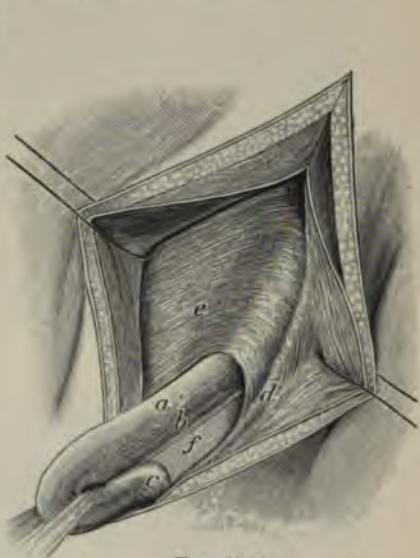
FIG. 1315.   FIG. 1316.

FIG. 1315.—Operation for the radical cure of inguinal hernia (left side), Bassini's method. *a.* Hernia and cord. *b.* Aponeurosis of external oblique muscle. *c.* Poupart's ligament.

FIG. 1316.—Operation for the radical cure of inguinal hernia, Bassini's method. *a* and *b.* Sac and cord raised *en masse* and held with fold of gauze. *c.* Cord entering scrotum. *d.* Poupart's ligament. *e.* Arched fibers of internal oblique muscle. *f.* Transversalis fascia.

spine of the ilium to the crest of the pubes; carry a traction suture between the borders of the respective flaps and draw them aside; expose and divide on a director the aponeurosis of the external oblique from the external abdominal ring along the line of incision for two or three inches (Fig. 1315); seize with forceps in turn the borders of the aponeurotic flaps and separate the upper inward to the outer edge of the rectus abdominis mus-

cle, and the lower down to and along Poupart's ligament, from the under-
lying tissues with the finger or handle of the scalpel, thus exposing to view
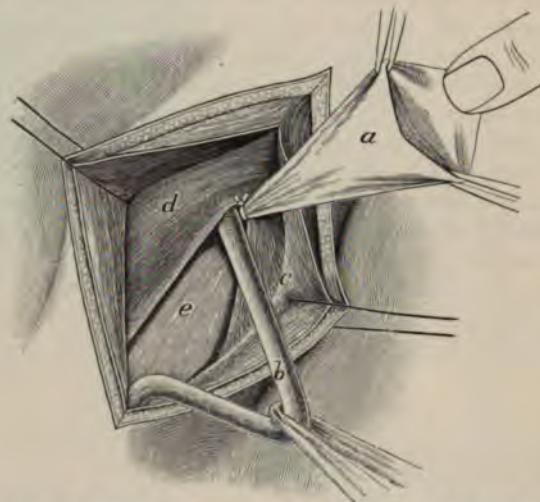
FIG. 1317.—Operation for the radical cure of inguinal hernia, Bassini's method. *a.* Sac
dissected from the cord, opened, examined, and neck ligatured. *b.* Cord. *c.* Pou-
part's ligament. *d.* Arched fibers of internal oblique muscle. *e.* Transversalis
fascia.

the contents of the inguinal canal; pass traction sutures through the
respective borders of the opening and draw them aside and raise *en masse*
from the inguinal canal with the fingers, aided with blunt curved scissors,

FIG. 1318.—Operation for the radical cure of
inguinal hernia, Bassini's method. Sac re-
moved (*c*), cord drawn aside, and stitching
of lower fibers of the internal oblique and
transversalis muscles (*b*) to Poupart's liga-
ment (*d*) from without inward. *a.* Trans-
versalis fascia.

the hernial sac and the cord (Fig.
1316); with the thumbs and fin-
gers, aided with forceps, separate
the cord and its vessels from the
sac from a point high within the
internal ring downward; open the
sac at the dependent part, exam-
ine the contents and return them
to the peritoneal cavity; transfix
the neck of the sac and ligature it
in halves with strong catgut, and
cut it off (Fig. 1317); draw back
the edges of the aponeurotic flaps
and raise the cord out of the
way; introduce beneath the cord
from before backward and within
outward, or the reverse, suc-
cessively four or five buried kan-
garoo-tendon sutures connecting
Poupart's ligament with the con-
joined tendon, and the lower

fibers of the internal oblique and transversalis (Fig. 1318); tie each snugly, thus joining directly with Poupart's ligament the conjoined tendon and a portion of the lower fibers of the internal oblique and transversalis muscles (Fig. 1319); replace the cord and unite the borders to the aponeurotic flaps over it with a continuous suture of catgut (Fig. 1320); close the integumentary incision without drainage and dress in the usual manner, confining the dressings in place with a hip spica.

The Precautions.—Poupart's ligament should be carefully outlined by palpation and introduction of the finger into the inguinal canal before making the primary incision, to avoid its misplacement. In transfixing and
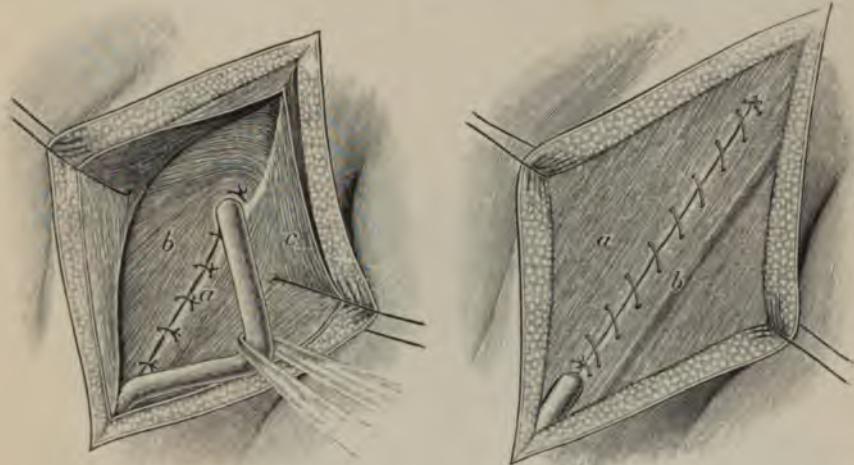
Fig. 1319.   Fig. 1320.

Fig. 1319.—Operation for the radical cure of inguinal hernia, Bassini's method.   Arched muscular fibers and conjoined tendon (*b*) sewed to Poupart's ligament (*a*).   *c.* Aponeurosis of external oblique muscle.

Fig. 1320.—Operation for the radical cure of inguinal hernia, Bassini's method.   Aponeurosis of external oblique (*a*) sewed with continuous sutures to Poupart's ligament (*b*).

tying omentum, do not forget that a transfixed vessel will bleed persistently, and, if returned to the abdominal cavity, may cause death from hæmorrhage before the cause is suspected; therefore, examine the omental stump carefully for oozing or insecure ligaturing before its return to the cavity. Pinching of the cord by approximation of the tissues in closing the canal with buried sutures is liable to happen and should be avoided. If the deep epigastric artery be tortuous or the needle be dipped incautiously in sewing, the vessel may be transfixed by the needle, causing perplexing hæmorrhage. The writer once had an experience of this kind. Twisting the sac is sometimes practiced, and serves to isolate it somewhat more and define the seat of the neck. However, if it be twisted too vigorously and be then transfixed and tied, and cut off before untwisting, the untwisting may loosen the ligature and render it insecure. Repair is made in this instance by sew-

ing together with a mattress or continuous catgut or silk suture the borders of the opening, the same as in other peritoneal wounds. It is safer practice to make the sac tense by downward traction, followed by upward pressure at its neck between the thumb and fingers to push away the contents, succeeded by interval inspection to note their absence before the neck of the
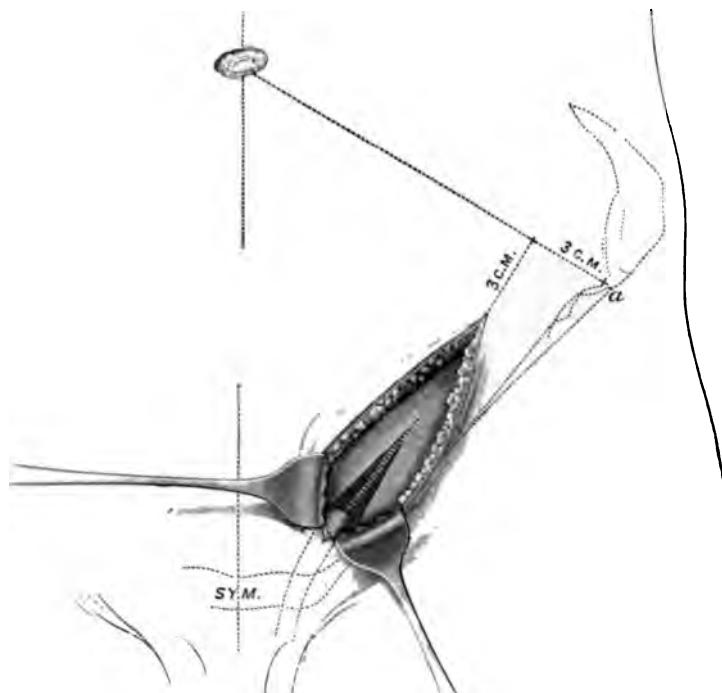
FIG. 1321.—Operation for the radical cure of inguinal hernia (left side). Halsted's method. An anterior superior, spinous process. Skin incision, exposure of external abdominal ring and the cord; line of division of aponeurosis of external oblique muscle (dotted line).

sac is transfixed. Even with this degree of care we once passed the needle through the mesenteric border of the intestine.

The Remarks.—The separation of the sac from the cord is often very difficult, especially in herniæ of congenital origin. It is even difficult sometimes to detect the presence of the sac, especially in recent and incomplete herniæ. The isolation of the sac is usually best accomplished by beginning at its neck and working downward. If the sac be very thin and illy defined, or difficult of isolation, its presence can be established and isolation facilitated often by the introduction into the sac of the finger through a small incision made for the purpose of guidance and support. The separation of the sac often requires great patience and much care to prevent unwise bruising and tearing of the vascular and fibrous tissues, thus hindering the prompt union so essential to final success. The adhesions between the sac and the contents, and between the contents themselves, must be

carefully overcome, and the contents returned to the abdominal cavity before the sac is further treated. The cord can be held out of the way easily with a fold of sterilized gauze while the buried sutures are being placed. Before introducing the kangaroo-tendon sutures, separate with the fingers the lower borders of the internal oblique and transversalis muscles from the transversalis fascia and from the conjoined tendon outward to the internal abdominal ring. In closing the canal from within outward, isolate completely the conjoined tendon and pass the end of the index finger behind it; pass a long, curved, dull needle, armed with a kangaroo-tendon suture, through Poupart's ligament just outside the spine of the pubis; carry the needle, guided by the finger, behind the conjoined tendon, thence through
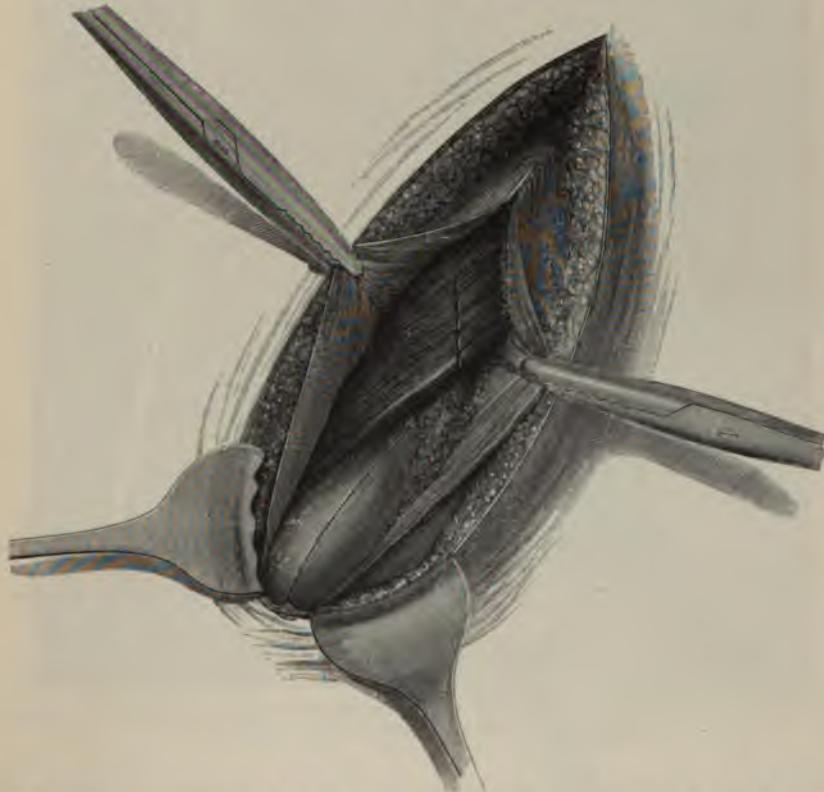
FIG. 1322.—Operation for the radical cure of inguinal hernia, Halsted's method. Aponeurosis of external oblique divided and drawn aside, exposing internal oblique and inguinal canal. Upper dotted line shows direction and extent of division of internal oblique muscle (*now omitted*). Lower dotted line, the direction and extent of division of the coverings of the sac.

its outer border to the front; pass the second suture through Poupart's ligament half an inch or so external to the first, thence along the finger beneath the arched fibers of the internal oblique and transversalis muscles half an inch or so from the first, then forward through the tissues to the

front. Stitches similar to the latter are repeated until the cord is nearly reached. Sometimes the muscular fibers beyond the internal ring are divided for about an inch (Fig. 1316, *a*), and the cord is pushed outward into the cut to increase the length of the canal and change the direction of the outer end. If this be done an extra suture is required. After closure of the integument the wound may be sealed with collodion. The dressing should be applied firmly along the course of the canal and the hip spica put
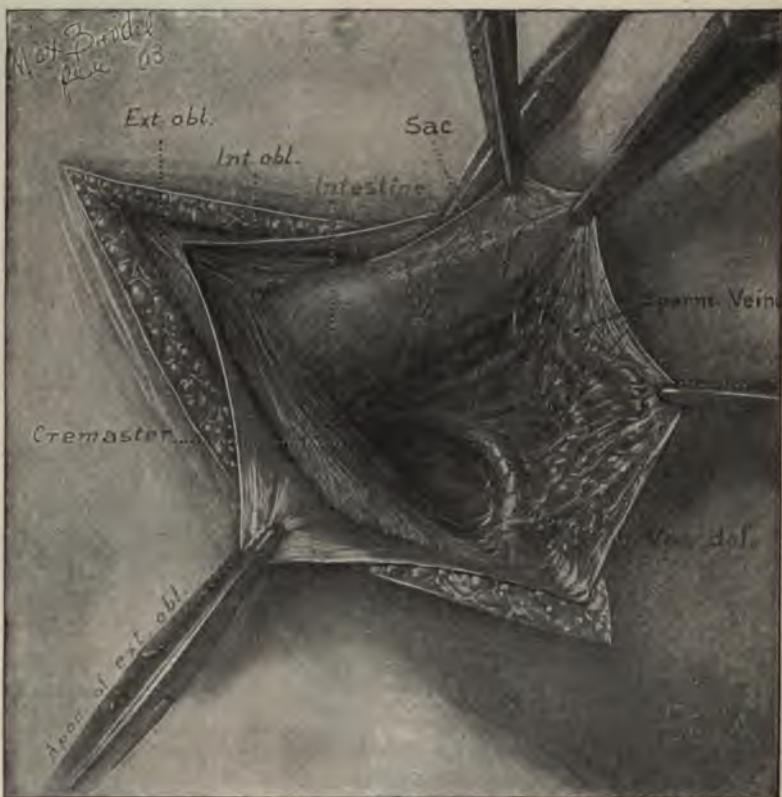
FIG. 1323.—Operation for radical cure of inguinal hernia (right side), Halsted's method. Showing the cord, cremaster muscle, and fascia.

on with the thigh slightly flexed, so that with extension the dressings are drawn firmly into place and held there until the limb is flexed again.

The Results.—*Bassini* reports 593 cases with 28 relapses. *Coley* reports 1160 cases of this method with 11 relapses. Coley reports also 600 cases with but a single death, which occurred after 489 consecutive successful operations. *Coley* reports (written communication) 230 cases of inguinal hernia in female, with no deaths and no relapses. Round ligament not transplanted, but left in angle of wound.

Halsted's Method of Operation (*Inguinal Hernia*).—Make an incision from a point 3 centimetres (1.18 inches) beyond and above the internal

abdominal ring to the spine of the pubes (Fig. 1321), exposing the aponeu-
rosis of the external oblique and the external abdominal ring; divide the
aponeurosis of the external oblique only (omitting division of the fibers of
the internal oblique and transversalis muscles and transversalis fascia) to a
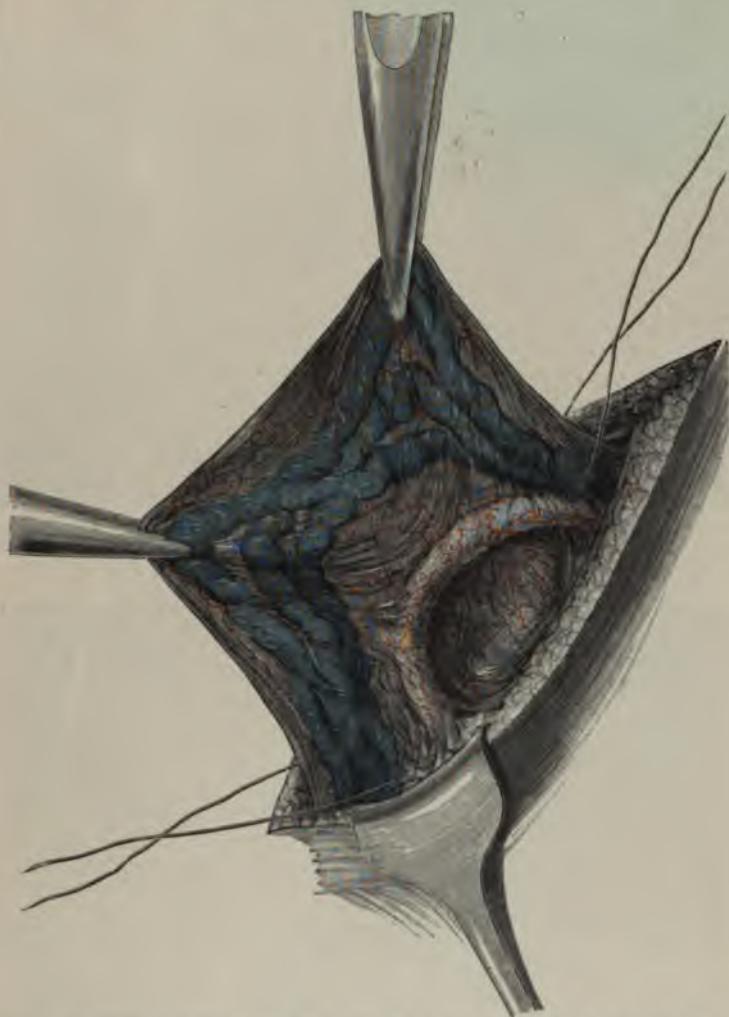
Fig. 1324.—Operation for the radical cure of inguinal hernia (left side), Halsted's
method. The excision of veins in hernia and in varicocele. The vas deferens and
its immediate vessels and the mesocord not disturbed.

point about an inch above the internal abdominal ring (Fig. 1322); draw
apart the borders of the incision, bringing into view the cord, the cremaster
muscle and fascia, which, with the hernial sac and constituents of the
cord) are then well displayed by raising the cord from its bed with forceps
(Fig. 1323); split cautiously the cremaster muscle and fascia on a line a

Operation for radical cure of inguinal hernia (right side), Halsted's method. ...sutures through cremaster and fascia, upward, beneath, and ...external oblique muscle.

Operation for radical cure of inguinal hernia. Halsted's method. Stitching of internal oblique and conjoined tendon to Poupart's ligament.

418

little above the cord; isolate locally and pull down quite firmly on the large veins of the cord and ligature them as high up as possible (Fig. 1324), also below, just without the external ring, with silk; dissect off, divide and remove the intervening portions of the veins, avoiding with great care any disturbance of the vas deferens; isolate and open the sac and return the contents to the abdominal cavity; detach thoroughly the upper end of the sac and close it by a transfixion, or by a purse-string suture at the highest possible point; thread both ends of this suture, after tying, with long curved needles, and carry the needles from below upward and inward be-

Fig. 1327.—Operation for radical cure of inguinal hernia, Halsted's method. Stitching part of sheath of rectus to Poupart's ligament.

neath the internal oblique muscle, about half an inch apart, through this muscle and tie the ends of the suture upon its surface, thus drawing up and fixing the neck of the sac in place; make the internal oblique muscle as free as possible, so that it may be united to Poupart's ligament without tension; pass several double fine silk sutures through the lower flap of the cremaster muscle and its fascia (Fig. 1325), thence upward, beneath, and through the internal oblique muscle in such a manner as to draw the cremasteric flap up into place, and securely fasten it there by tying the sutures; stitch the internal oblique muscle, the conjoined tendon (Fig. 1326), and perhaps a part of the sheath of the rectus (Fig. 1327) to Poupart's ligament with catgut sutures (Fig. 1327); overlap the flaps of the aponeurosis of the external oblique (Fig. 1328), uniting them in place above (Fig.

1328) and at the border (Fig. 1329) by means of silk or catgut sutures; close the remaining part of the wound with buried silver suture (Fig. 1331) and cover the line of union with several layers of silver foil. The
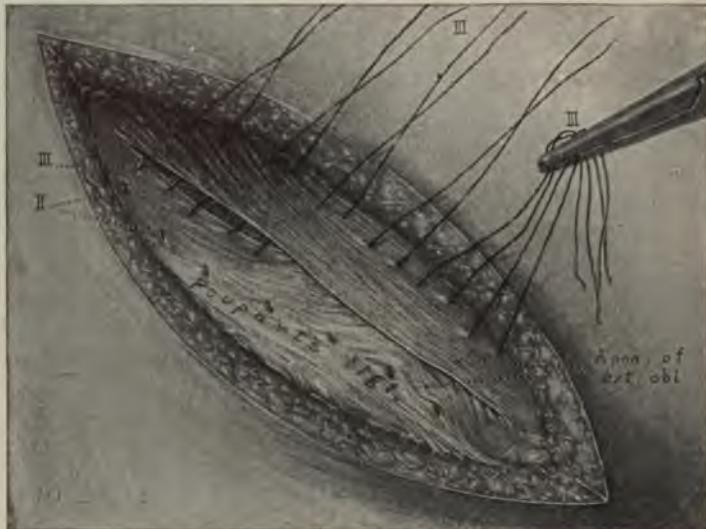
Fig. 1328.—Operation for radical cure of inguinal hernia, Halsted's method. Overlapping aponeurosis of external oblique.

wound is not dressed for two weeks, when the wire is withdrawn. The patients are kept in bed from eighteen to twenty-one days. The following cut illustrates (Fig. 1330) lucidly the relations of the several tissues after completion of the operation.

Fig. 1329.—Operation for radical cure of inguinal hernia, Halsted's method. Sewing border.

The Comments.—In order to secure sufficient relaxation of the internal oblique, it is often necessary to make relaxation cuts into the sheath of the rectus beneath the external oblique. However, this cutting ought not to be done if the sheath of the rectus is to be utilized for reparative purposes (Fig. 1327), and not at all until after the suturing of the border of the internal oblique to Poupart's ligament from without inward, develops the need for it.

The Precautions.—The vas deferens should be treated with great care, not even handled, if possible to avoid it. Traumatism in handling or in raising the cord from its bed often

FIG. 1330.—Operation for radical cure of hernia, Halsted's method. Transverse section, showing relation of tissues after operation.

causes epididymitis and atrophy of the testicle. The latter condition is the result of the former disease. Therefore, in traumatism of the cord, transplant the veins instead of excising them, thereby reducing the size of the
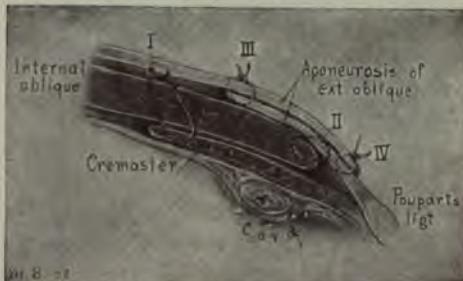
FIG. 1331.—Operation for the radical cure of inguinal hernia (left side), Halsted's method. The introduction of the subcuticular continuous wire suture. The suture is carefully withdrawn after suitable union is secured.

cord and the dangers of epididymitis and atrophy. If the conjoined tendon be fatty or feeble, re-enforce it with the rectus muscle or with its fascia.

76
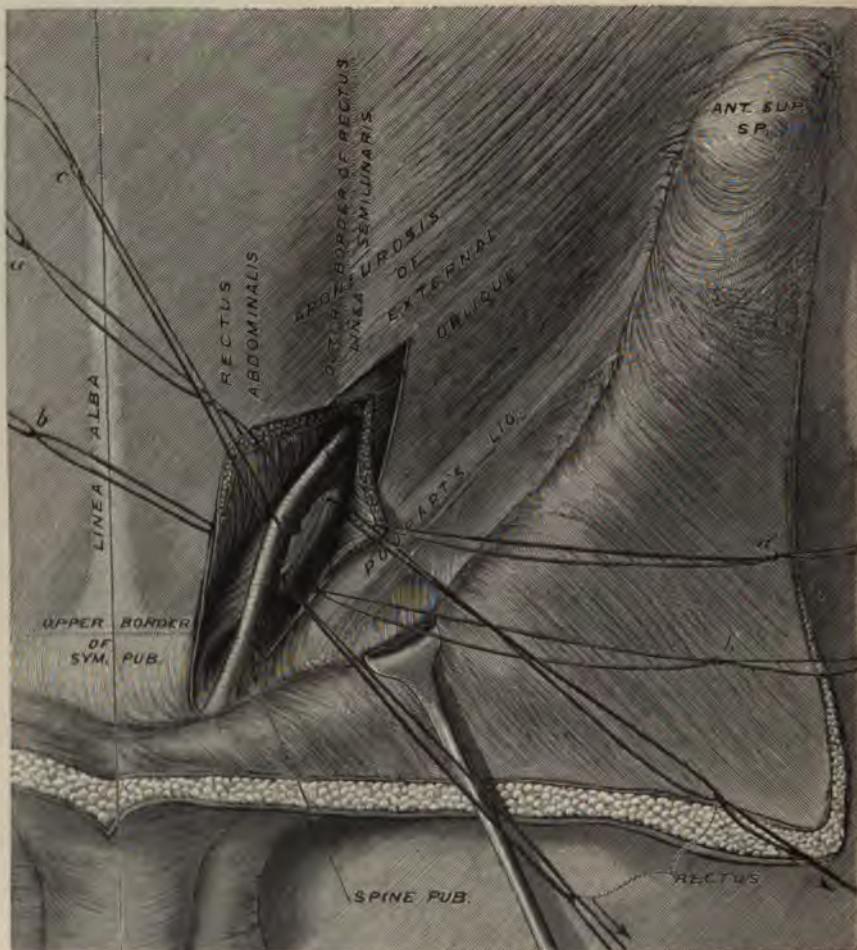
FIG. 1332.—Operation for the radical cure of inguinal hernia, Bloodgood's modification of Halsted's method. Sac excised and peritoneal cavity closed; internal oblique muscle divided, rectus exposed and transplanted inward, ready for deep sutures. *a, a'*. Traction loops applied to divided borders of the internal oblique muscle. *b, b*. Traction loops applied to borders of aponeurosis of external oblique muscle. *c*. Cord raised permitting passage of the border of the rectus.

The Results.—In 195 cases 5.6 per cent relapsed in from six months to nine years. With primary union 3.3 per cent relapsed; with secondary, 25 per cent. The following communication from Dr. Halsted to us is expressive of its own significance:

"We still employ silver wire for subcutaneous suture and find it as highly important as ever. In 118 cases in which we have excised the veins of the cord there was no recurrence at the seat of the transplanted cord, whether suppuration occurred or not. The atrophy of the testicle, which had occasionally followed excision of the veins, we no longer fear because we employ great cautio in excising them.

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be utilized for repara-
oses (Fig. 1327), and
until after the sutur-
e border of the inter-
ue to Poupart's liga-
om without inward,
he need for it.

Precautions.—The vas
should be treated with
e, not even handled,
e to avoid it. Trau-
handling or in rais-
rd from its bed often

FIG. 1330.—Operation for radical cure of hernia,
Halsted's method. Transverse section,
showing relation of tissues after operation.

idymitis and atrophy of the testicle. The latter condition is the
he former disease. Therefore, in traumatism of the cord, trans-
veins instead of excising them, thereby reducing the size of the

tion for the radical cure of inguinal hernia (left side), Halsted's
introduction of the subcuticular continuous wire suture. The suture
drawn after suitable union is secured.

gers of epididymitis and atrophy. If the conjoined tendon
re-enforce it with the rectus muscle or with its fascia.

Fig. 1325.—Operation for radical cure of inguinal hernia (right side), Halsted's method. Passing double silk sutures through cremaster and fascia, upward, beneath, and through internal oblique muscle.
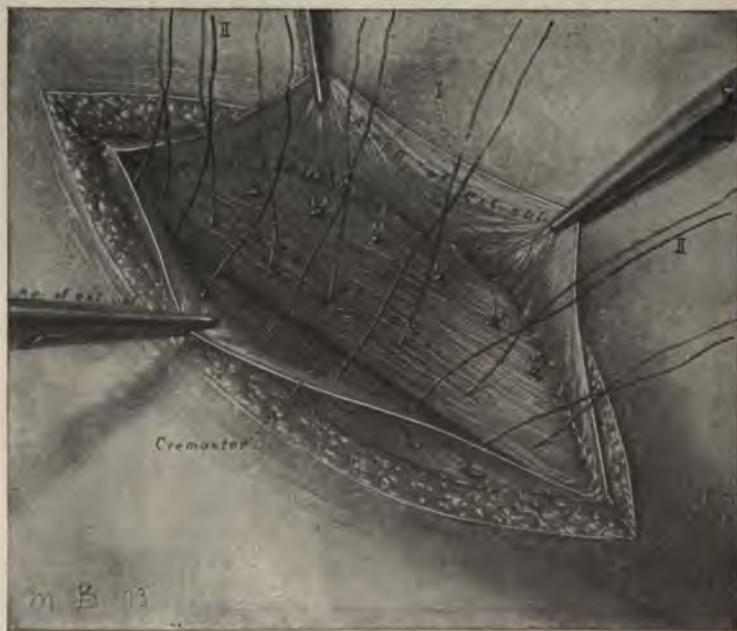
Fig. 1326.—Operation for radical cure of inguinal hernia, Halsted's method. Stitching of internal oblique and conjoined tendon to Poupart's ligament.

1136

little above the cord; isolate locally and pull down quite firmly on the large veins of the cord and ligature them as high up as possible (Fig. 1324), also below, just without the external ring, with silk; dissect off, divide and remove the intervening portions of the veins, avoiding with great care any disturbance of the vas deferens; isolate and open the sac and return the contents to the abdominal cavity; detach thoroughly the upper end of the sac and close it by a transfixion, or by a purse-string suture at the highest possible point; thread both ends of this suture, after tying, with long curved needles, and carry the needles from below upward and inward be-

Fig. 1327.—Operation for radical cure of inguinal hernia, Halsted's method. Stitching part of sheath of rectus to Poupart's ligament.

neath the internal oblique muscle, about half an inch apart, through this muscle and tie the ends of the suture upon its surface, thus drawing up and fixing the neck of the sac in place; make the internal oblique muscle as free as possible, so that it may be united to Poupart's ligament without tension; pass several double fine silk sutures through the lower flap of the cremaster muscle and its fascia (Fig. 1325), thence upward, beneath, and through the internal oblique muscle in such a manner as to draw the cremasteric flap up into place, and securely fasten it there by tying the sutures; stitch the internal oblique muscle, the conjoined tendon (Fig. 1326), and perhaps a part of the sheath of the rectus (Fig. 1327) to Poupart's ligament with catgut sutures (Fig. 1327); overlap the flaps of the aponeurosis of the external oblique (Fig. 1328), uniting them in place above (Fig.

muscle, which we formerly cut away. This muscle unaided has frequently
made such a complete and strong-looking closure that we have felt that the
hernia would be well cured if the operation were abandoned at this stage.
The closure with the cremaster seems almost ideal in some cases, it being
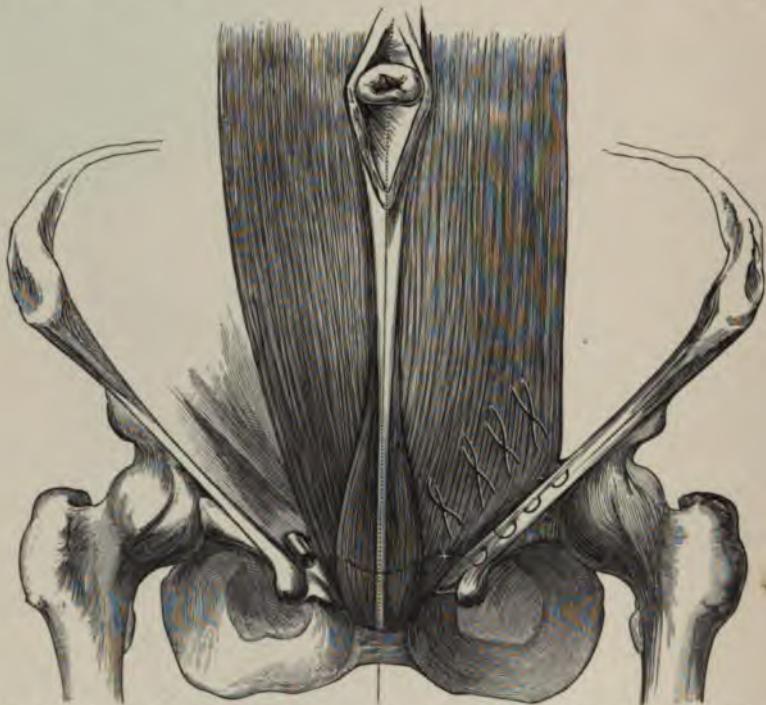
FIG. 1334.—Operation for the radical cure of inguinal hernia, Bloodgood's modification
of Halsted's method. The transplanted border of the rectus united to Poupart's
ligament, showing slight change in the direction of its fibers.

so true to one of the great principles of this class of surgery—*there is no
tension.*"

Bloodgood discovered that we had a certain percentage of recurrences
in the lower angle of the wound, and devised an operation to remedy this.
It is only in a small proportion of cases that we find it necessary to trans-
plant a portion of the rectus muscle."

Bloodgood's Modification.—*Bloodgood*, noting the occasional defective
state of the conjoined tendon due to either acquired or congenital causes,
sought to strengthen that part of the anatomy by transplantation of a
portion of the rectus muscle, which is done in the following manner:
Before inserting the deep sutures for closure of the canal draw upward and
inward the aponeurosis of the external and internal oblique muscles, thus
exposing the sheath of the rectus muscle; divide the sheath at the outer
border of the muscle from below upward for about two inches; pass through
the bulging border of the muscle two or three large black silk traction
sutures, and draw the border outward and downward (Fig. 1332); pass the

deep sutures of silver wire (Fig. 1333) the same as before (in Halsted's method), so that they will include in proper order the sheath and fibers of the rectus along with the other tissues; tie the sutures, thus uniting to Poupart's ligament the border of the rectus from the symphysis to a point corresponding to the outer limit of the transplanted cord (Fig. 1334).

The Remarks.—This modification, while originally supplementary to Halsted's method, can be applied to others in which the canal is freely laid open.

The Results.—In 100 cases thus far performed no recorded relapse has taken place. There now appears to be no reasonable doubt of the fact that this expedient can be safely utilized and confidently trusted.

Kocher's Method (*Inguinal Hernia*).—Make an incision a finger's breadth above, parallel with, and corresponding to the inner two thirds of Poupart's ligament, down to the aponeurosis of the external oblique; expose the aponeurosis along the line of incision; expose the hernial sac at the external ring (Fig. 1335) by extension downward of the primary incision, and careful division of the several tissues lying above it; isolate the sac at this situation in the usual manner from the structures of the cord, and carefully separate and withdraw it from the scrotum (Fig. 1336); separate the sac from the tissues above while drawing downward firmly upon it, until the part of the sac that occupied the internal abdominal ring is exposed; reduce and re-

Fig. 1335.—Operation for the radical cure of inguinal hernia, Kocher's method. Exposure of the aponeurosis of the external oblique muscle, of the external abdominal ring, and the cord. Short, transverse incision (*a*) opening for introduction of forceps.

tain in position the contents of the sac; transfix the upper limit of the sac with a needle armed with a strong silk ligature and tie it in halves; make a small opening through the aponeurosis above and internal to Poupart's ligament (Fig. 1335); introduce through the opening (*a*) and push

along the under surface of the aponeurosis, through the external abdominal ring, a long, curved dressing forceps (Fig. 1336); seize the fundus of the sac with the forceps and withdraw it, dragging the sac upward through the opening (Fig. 1337); draw upward and outward on the sac away from the cord, pulling the neck of the sac well into the aponeurotic incision; transfix and sew the neck of the sac to the abdominal wall; turn the sac downward on the aponeurosis along the course of the inguinal canal; introduce the finger into the canal to protect the cord, while several sutures are passed as deeply as possible through the aponeurosis and sac in the manner shown (Fig. 1338), and tied firmly; cut away the remainder of the sac, and pass a deep suture through the borders of the internal ring close to and beneath the neck of the sac; finally, with the finger as a guide, pass several sutures through the lower fibers of the internal oblique and transversalis muscles so as to narrow the inguinal canal and fortify it in front when tied.

FIG. 1336.—Operation for the radical cure of inguinal hernia, Kocher's method. Sac separated and end seized by forceps passed through the transverse incision (a) down the inguinal canal.

The Modification.—Carry the sac outward and upward—instead of downward on the aponeurosis—toward the anterior iliac spine, and sew it to the aponeurosis of the external oblique, and thus draw the peritonæum still further outward, and make it impossible for a hernia to escape along the course of the cord (Kocher).

Kocher has still later modified his method of treatment of the sac. He isolates the sac at the external abdominal ring and frees it as high as possible the same as before. He now seizes the apex of the unopened sac with narrow curved forceps and invaginates it upward into the abdominal cavity to a point just external to the internal abdominal ring; presses outward the end of the forceps against this point of the abdominal wall; makes an incision at this point a quarter of an inch long through the aponeurosis and muscles down to the parietal peritonæum; pushes through the opening
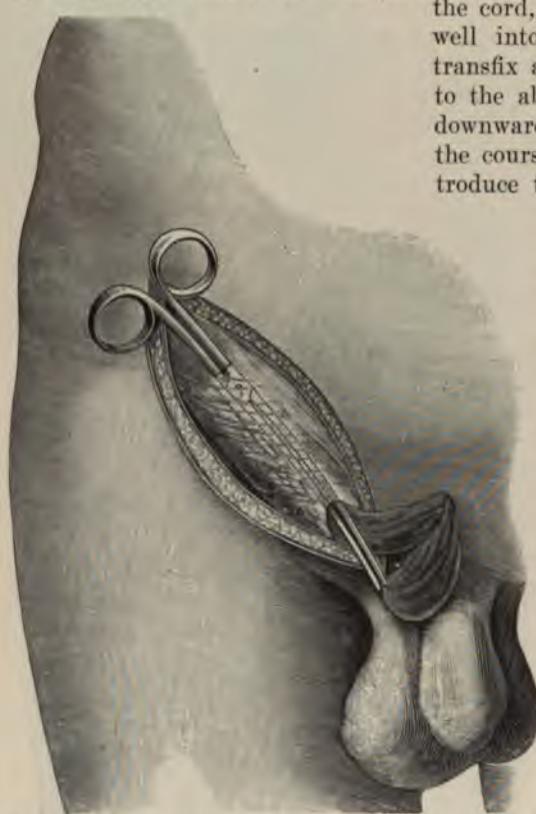
by means of the forceps the parietal peritonæum and the invaginated sac (Fig. 1339); incises the peritonæum and catches the divided borders to prevent retraction; pulls forcibly through the opening the entire sac, removing the forceps at the same time; crushes with forceps the base of the sac and transfixes it and the peritonæum with silk, tying it in halves; cuts off the sac, pushes the stump beneath the aponeurosis and closes the opening in it with the undivided ligature of the neck of the sac (Fig. 1340). Finally he closes the canal with sutures as indicated in Fig. 1340, *b*).

The Remarks.—This method is applicable to those cases in which the sac is not too large nor too thick to lead to impairment of the strength of the anterior wall of the canal. In the instances of incomplete herniæ it is better to employ another method of practice. During the passage of the final sutures directed to narrowing the canal careful attention is necessary to avoid puncture and perhaps inclusion of the cord.

The Results.— In 111 operations no death ensued; recurrence happened in 3.8 per cent of 528 cases within from six months to two years and upward. Of 83 cases by the latest modification but one relapse is reported.

Macewen's Method (*Inguinal Hernia*). — *Macewen's* operation for radical cure of hernia

Fig. 1337.—Operation for the radical cure of inguinal hernia, Kocher's method. Sac drawn out through short transverse incision. Transfixion of upper limit of sac with silk ligature.

is one of the best of the earlier methods practiced, and before the advent of the more modern methods it was regarded more highly in this form than any other plan of procedure. After exposure of the inguinal canal and internal ring the operation is divided into two steps: 1, the formation of an abdominal serous pad; 2, the closure of the inguinal canal. The following description is in Macewen's own language:

"A. *The Formation of a Pad on the Abdominal Surface of the Circumference of the Internal Ring.*—1. Free and elevate the distal extremity of the sac, preserving along with it any adipose tissue that may be adherent to it; when this is done, pull down the sac, and, while maintaining tension upon it, introduce the index finger into the inguinal canal (Fig. 1341), separating the sac from the cord and from the parietes of the canal.

"2. Insert the index finger outside the sac until it reaches the internal ring; there separate with its tip the peritonæum for about half an inch round the whole abdominal aspect of the circumference of the ring.

"3. A stitch is secured firmly to the distal extremity of the sac. The end of the thread is then passed in a proximal direction several times through the sac, so that, when pulled upon, the sac becomes folded upon itself, like a curtain (Fig. 1342).

"The free end of this stitch, threaded on a hernia needle, is introduced through the canal to the abdominal aspect of the fascia transversalis, and there penetrates the anterior abdominal wall about an inch above the upper border of the internal ring. The wound in the skin is pulled upward, so as to allow the point of the needle to project through the abdominal muscles without penetrating the skin (Fig. 1343).
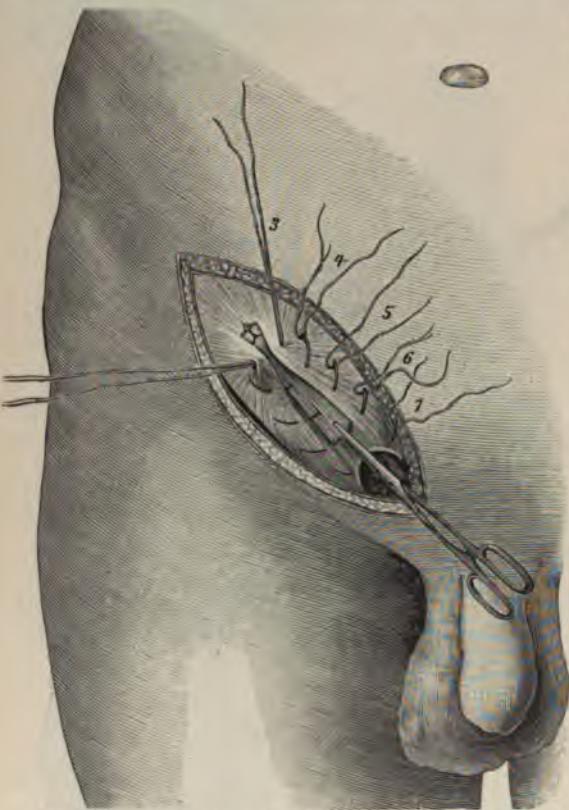
Fig. 1338.—Operation for the radical cure of inguinal hernia, Kocher's method. Sac drawn downward on aponeurosis and sewed in place.

"The thread is relieved from the extremity of the needle when the latter is withdrawn. The thread is pulled through the abdominal wall; and, when traction is made upon it, the sac, wrinkling upon itself, is thrown into a series of folds, its distal extremity being drawn farthest backward and upward. An assistant maintains traction upon the stitch until the introduction of the sutures into the inguinal canal; and, when this is completed, the end of the stitch is secured by introducing its free extremity several times through the superficial layers of the external oblique muscles. A pad

of peritonæum is thus placed upon the abdominal side of the internal opening, where, owing to the abdominal aspect of the circumference of the internal ring having been refreshed, new adhesions may form.

"B. *Closure of the Inguinal Canal.*
—The sac having been returned into the abdomen and secured to the abdominal circumference of the ring, this aperture is closed in front of it in the following manner: The finger is introduced into the canal, and lies between the inner and lower borders of the internal ring, in front of and above the cord. It makes out the position of the epigastric artery so as to avoid it. The threaded hernial needle is then introduced, and, guided by the index finger, is made to penetrate the conjoined tendon in two places (Fig. 1344): First, from without inward, near the lower border of the conjoined tendon; secondly, from within outward, as high up as possible on the inner aspects of the canal. This double penetration of the conjoined tendon is accomplished by a single screw-like turn of the instrument. One single thread is then withdrawn from the point of the needle by the index finger, and, when this is accom-

Fig. 1339.—Operation for the radical cure of inguinal hernia, Kocher's method. Invaginated sac, pushed through divided borders, held apart by forceps.

plished, the needle, along with the other extremity of the thread, is removed. The conjoined tendon is therefore penetrated twice by this thread, and a loop left on its abdominal aspect (Fig. 1345).
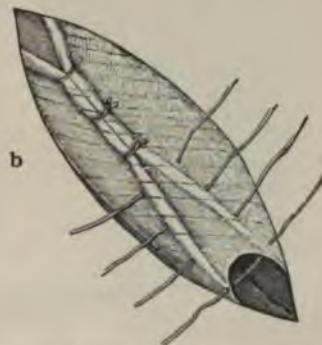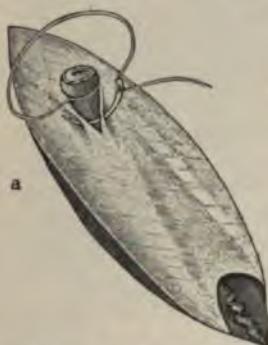
Fig. 1340.—Operation for the radical cure of inguinal hernia, Kocher's method. *a*. Sac cut off, suture tied round stump and used to close opening after stump is replaced. *b*. Strengthening sutures of anterior wall in place and part of them tied.

"The other hernia needle, threaded with that portion of the stitch which comes from the lower border of the conjoined tendon, guided by the index finger in the inguinal canal, is introduced from within outward,

FIG. 1341.—Operation for the cure of inguinal hernia, Macewen's method. Separating the sac from the cord and walls of the canal; folded sac lying behind the finger.
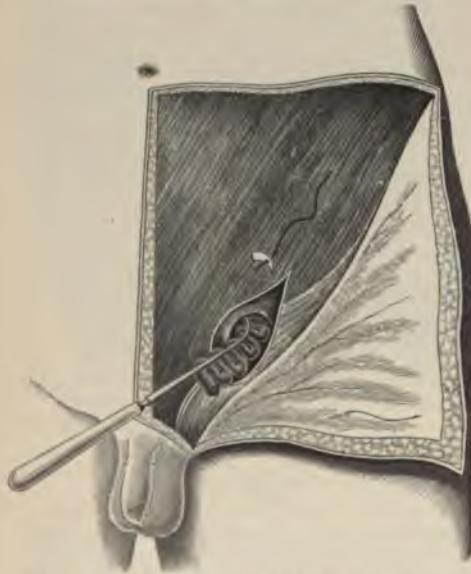
FIG. 1343.—Operation for the radical cure of inguinal hernia, Macewen's method. Carrying the suture of the sac from behind forward through the abdominal muscles, at a point about an inch above the internal ring.

through Poupart's ligament, which it penetrates at a point on a level with the lower stitch in the conjoined tendon (Fig.

FIG. 1342.—Operation for the radical cure of inguinal hernia, Macewen's method. The pad formed by transfixion of the sac.

1346). The needle is then completely freed from the thread and withdrawn.

"The needle is now threaded with that portion of the catgut which protrudes from the upper border of the conjoined tendon, and is introduced from within outward through the transversalis and internal oblique muscles, and the aponeurosis of the external oblique at a level corresponding with that of the upper stitch in the conjoined tendon. It is then quite freed from the thread and withdrawn (Fig. 1347).

"There are now two free ends of the suture on the outer surface of the external oblique, and these are continuous with the loop on the abdominal aspect of the conjoined tendon (Fig. 1347). To complete the suture the two free ends are drawn tightly together and tied in a reef knot. This unites firmly the internal ring.

"The same stitch may be repeated lower down in the canal
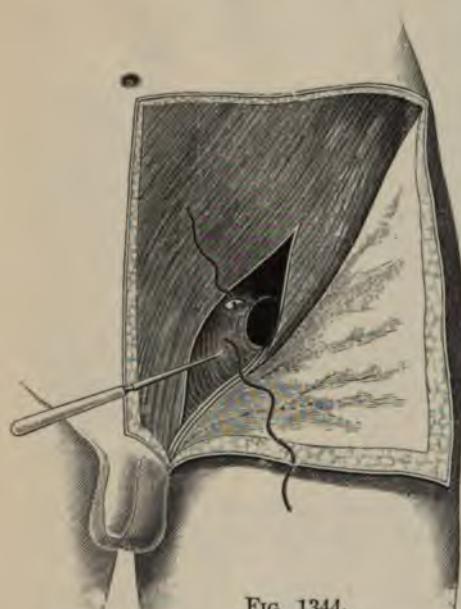
Fig. 1344.
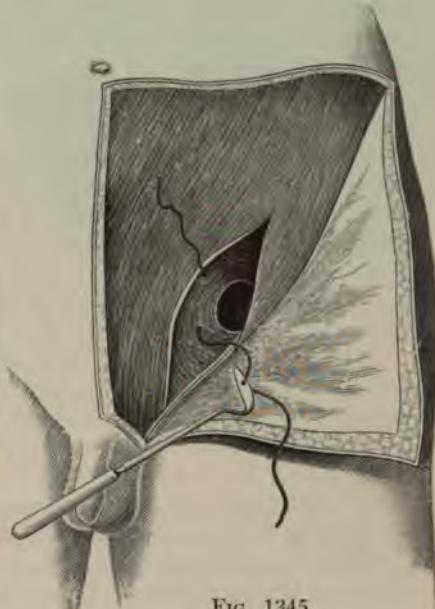
Fig. 1345.

Fig. 1344.—Operation for the radical cure of inguinal hernia, Macewen's operation. Needle passing through conjoined tendon.

Fig. 1345.—Operation for the radical cure of inguinal hernia, Macewen's operation. Ligature carried through the conjoined tendon in two places.
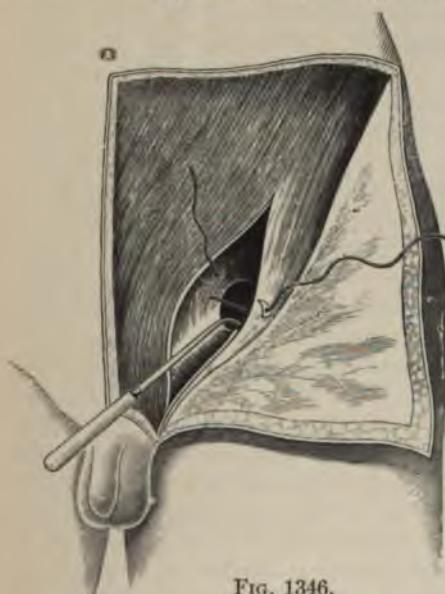
Fig. 1346.
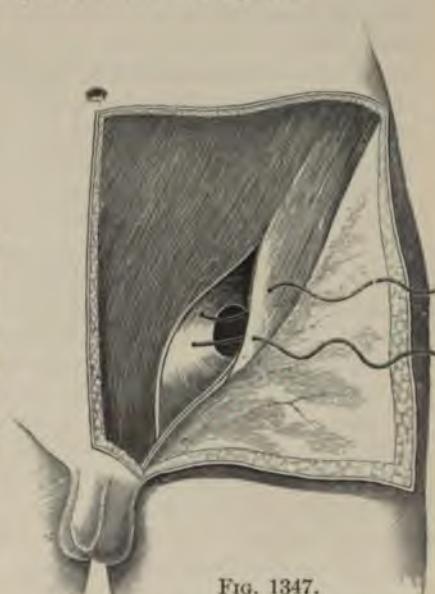
Fig. 1347.

Fig. 1346.—Operation for the radical cure of inguinal hernia, Macewen's operation. The lower extremity of the ligature being carried through Poupart's ligament.

Fig. 1347.—Operation for the radical cure of inguinal hernia. The upper extremity of the ligature passed through Poupart's ligament and the ends ready for tying.

if thought desirable. In adults it may be well to do so when the gap in the abdominal parieties is wide. The pillars of the external ring may likewise be brought together.

"In order to avoid compression of the cord, it ought to be examined before tightening each stitch. The cord ought to lie behind and below the sutures, and be freely movable in the canal. It is advisable to introduce all the necessary sutures before tightening any of them. When this is done, they might be all experimentally drawn tight, and maintained so while the operator's finger is introduced into the canal to ascertain the result. If satisfactory, they are then tied, beginning with the one at the internal ring, and taking up in order any others which may have been introduced. In the great majority of cases the stitch in the internal ring is all that is required.

"During the operation the skin is retracted from side to side, to bring the parts into view and to enable the stitches to be fixed subcutaneously. When the retraction is relieved, the skin falls into its normal position, the wound being opposite the external ring. The operation is therefore partly subcutaneous."

The Results.—Macewen's personal experience in his own method shows 2 deaths in 164 cases; 107 were traced with 5 relapses; 93 cases were cured at the end of from two to ten years.

Deaver, after opening the inguinal canal through the usual free incision, exposes and separates the hernial sac the entire length, makes a small opening into it, frees the sac of adhesions within, reduces the contents into the abdominal cavity, folds the sac upon itself, carries it into position beneath the peritonæum, placing it at the site of the internal abdominal ring, and fastens it there by sutures to the abdominal wall. He then closes the canal from within outward by means of interrupted (not mattress) silver sutures introduced substantially into the tissues, after the manner of Halsted. This modification adds to the Bassini and Halsted methods the subperitoneal pad of Macewen. Since only theoretical claims appear as yet, the assumed advantages of the proposition await practical demonstration.

Fowler presents a modification which, while adding to the dangers of operation, certainly appears to offer increased advantages; but whether or not these qualities are mutually commensurate experience only can determine. The purpose of the operation is to obliterate the internal ring, which is accomplished as follows: Expose the inguinal canal out to the internal ring by division of the overlying structures; isolate the cord and sac from the surrounding tissues and from each other to the internal ring; open the sac and reduce the contents; cut off the sac at the neck, grasping the divided borders with forceps; draw the cord out of the way; locate, isolate, and divide the deep epigastric vessels between two ligatures; introduce the index finger through the opening at the neck of the sac into the peritoneal cavity and carry it along the posterior wall of the canal; press the finger forward to make the tissues tense and divide them from without inward on the finger; place the cord within the peritoneal cavity, while carefully preventing the escape of intestines; beginning outside of the internal ring, approximate broadly the serous surfaces along the divided borders and unite them with each other by through-and-through sutures passed from side to

side; close and obliterate the inguinal canal, and unite the borders of the external wound respectively with absorbable sutures.

The Remarks.—Fowler suggests in those instances in which the internal ring is greatly enlarged in all directions, a slit be made at the lower border, so that the cord will enter more readily the abdominal cavity. During the sewing of the peritonæum and the superimposed fascia, any previous undue relaxation of these tissues can be remedied. The inner angle of the wound should be low enough to cause slight curving of the cord upward and forward as it passes out, permitting it, however, to escape unconstricted because of change in direction of sewing.

The General Precautions.—The vas deferens should be carefully preserved from injury for obvious reasons. The separation of the sac from the structures of the cord should be cautiously practiced to avoid unnecessary mutilation and subsequent necrosis of the tissues. It is often wiser to separate the sac from the cord by tearing at the points of great adhesion than to endeavor to separate the structures. In tying the neck of the sac, transfixion should be practiced in order to keep the ligature in proper place after the sac is cut away and intra-abdominal pressure is brought to bear upon it. Mattress sutures meet the same indication. Careful inspection of the interior of the sac should be practiced before ligaturing to note if it be free of abdominal contents. Twisting of the sac; passing the fingers and thumb from above downward on the outside; introduction of the finger to press back the contents, and tying of the sac across the end of the finger as it is withdrawn are each good methods of practice to prevent the inclusion of unwelcome contents. Prompt and uninterrupted union are the great desiderata of success, therefore irritating sutures, oozing, and granulating surfaces should be eschewed. Hæmorrhage from faulty tying of the omentum has been known to cause death, hence the omental stump should be tied in small sections (Figs. 1297 and 1298) and not returned until after the arrest of oozing is assured. Injury of the spermatic and epigastric arteries may give rise to severe and even fatal hæmorrhage. Ligature of the omentum may be followed by perforation of the bowel if tied too close to that organ. Suppuration of the omental stump and injury of the bladder when in the sac (Curtis and Gibson) are among the complicating features of the operation. In the female the round ligament should be carefully avoided.

The General Remarks.—Non-absorbable sutures are regarded by Bull and Coley, who have had a large experience and an unusual opportunity of observing the results of the work of others, as inferior to the absorbable. Silk, silkworm gut, and silver wire especially belong to the former class, chromicized catgut and kangaroo tendon to the latter. With this discrimination we are disposed to agree. The fact that delayed and faulty union adds ten to twenty per cent to the list of failures should lead the operator to faithfully elminate their causes.

The writer finds much advantage is gained by opening the sac early in the course of dissection near to the upper end, sufficiently to admit the index finger, which serves admirably as a guide and support during the complete separation of the tissues from it.

The lower portion of a long hernial sac may be left behind in the wound, or be utilized by tying or sewing to form a tunica vaginalis in complete congenital cases.

The After-treatment.—A strip of iodoform gauze placed upon closed borders of the wound surmounted with dry aseptic gauze firmly tied in place with a spica meets the usual demands of the dressing. In the instance of children a plaster-of-Paris spica aids in securing quiet and uniform pressure. If the inner aspect of the splint be painted with a solution of shellac the discharges will not soil the dressing. Rubber tissue may be used instead. The patient is kept in bed for two or three weeks after operation, or until firm union has taken place. The abdominal support of the dressings is quite sufficient for this period of treatment. After recovery artificial support by means of a bandage or truss is rarely practiced except in those cases presenting special indications for their use. The avoidance of severe physical effort for some months, however, is strongly urged.

The General Results.—Operations in childhood and youth are followed by the best results. Patients under four and above fifty years of age should be approached with care in this respect, and only in the presence of special demands for the operation. In selected cases and with skilled operators the death rate is scarcely above one per cent. In children it is even less than this. The final outcome is difficult to establish, since many of the cases are lost to the observation of the operator. However, from 60 to 90 per cent remain cured for a number of years—ten and more. Relapses in 64.5 per cent of the cases occur within six months after the operation; 80 per cent during the first year and 20 per cent after that time. In 71 per cent of the relapses the patients were above thirty years of age and under thirty in 29 per cent (Coley). *Coley* collected 10,500 cases operated upon since 1890, with a general death rate of 0.9 of 1 per cent. Bassini's method is performed more often now than any other. As a rule, a relapsing hernia in this
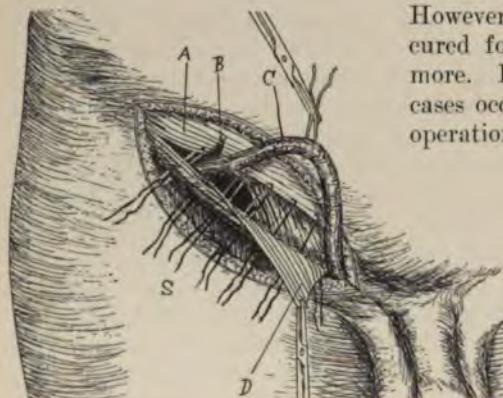
FIG. 1348.—Operation for the radical cure of inguinal hernia, Andrews's method. *A.* Aponeurosis of external oblique. *B.* Incision sometimes made forward. *C.* The cord *D.* Reflected aponeurotic flap. *S.* Sutures.

method is more easily controlled than was its antecedent, except in the instance of the repair by granulation.

Andrews's Method.—This method is characterized as "the lap-joint or imbracated" method by the inventor for reasons that will be obvious as the plan of operation is set forth.

The Operation.—Make an incision through the integuments and fasciæ an inch and a quarter above Poupart's ligament from near the pubis to a

point a line above the internal abdominal ring; divide the aponeurosis of the external oblique in the course of its fibers to the same extent as the preceding incision; open the hernial sac and reduce the contents, ligaturing the sac as high up as possible; separate the peritonæum with the fingers from the inner surface of the abdominal wall around the neck of the sac for the distance of about an inch; pull down the sac and cut it off below the ligature; strip from the spermatic cord its lobules of fat, raise it from the canal and hold it aside with retractors; pass a long curved needle armed with a suture, from without inward through Poupart's ligament, thence upward across the canal, "picking up" from within outward the transversalis fascia, the lower fibers of the internal oblique muscle or conjoined tendon and piercing the aponeurosis of the external

FIG. 1349.—Operation for the radical cure of inguinal hernia, Andrews's method. *A.* Line of suturing. *B.* The cord. *D.* Reflected aponeurotic flap.

oblique, thus including all of the layers of the abdominal wall; form a mattress stitch by reversing the course of the needle at a short distance from the points of emergence, carrying through the respective tissues in the reverse order to the external surface of Poupart's ligament not far from the points of beginning (Fig. 1348); place in this manner along the line of the wound from three to six stitches, according to the requirements of the case; tie first the upper two stitches, noting the effect on the circulation of the cord by the tightening of them, thereby avoiding constriction; tie the remaining stitches, leaving the knots as before outside of Poupart's ligament; restore the cord to the new canal (Fig. 1349) and turn up the lower portion of the aponeurosis of the external oblique, and stitch the border to the upper portion, thus forming a new inguinal canal (Fig. 1350); close the integumentary incision without drainage and dress the part in the usual manner.

FIG. 1350.—Operation for the radical cure of inguinal hernia, Andrews's method. Aponeurotic flaps united to form new canal.

The Remarks.—This method of arrangement of the tissues of the abdominal wall provides a firm and steadfast repair of a vulnerable part of the abdomen. The incision of the aponeurosis need not invade the exter-

nal ring except for some special reason. The overlapping of the tissues affords an area of stronger union than that of divided borders. The seemingly increased tension caused by the overlapping does not appear to cause an unfavorable outcome.

The Results.—Dr. Andrews reports over 1,000 cases treated by fifteen different operators with no deaths and with less than 5 per cent relapses. *Ferguson* * describes an admirable method of practice which provides a cutaneous semilunar flap, leaves the cord undisturbed, removes enlarged cremasteric fibers and veins, and unusual fatty deposits that increase unduly the size of the cord, and strengthens the internal ring by tightening the fascia around the cord with sutures.

McArthur's Autoplastic Suture in Radical Cure of Hernia.—McArthur's ingenious and practical conception in surgical technique affords opportunity to suture living tissues by means of their counterpart. The agent for the purpose is always at hand and is usually in a suitable state for the purpose.

The Technique.—Expose the aponeurosis of the external oblique in the usual manner for a radical cure operation; divide carefully the aponeurosis

Fig. 1351.—McArthur's autoplastic suture, cord raised, autoplastic sutures formed.
A. Aponeurosis of external oblique muscle. *C.* Cord. *T. S.* Tendon sutures.
C. T. Conjoined tendon. *T. F.* Transversalis fascia. *I. O.* Internal oblique.

parallel with its fibers and separate the borders of the incision from the underlying tissues; isolate and treat the hernial sac as may seem desirable;

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* Jour. Amer. Med. Association, vol. xxxiii, 1899.

slit from the lower border of the aponeurosis from the external pillar outward to the muscular fibers a ribbon of tissue from an eighth to three sixteenths of an inch in width, and sever it at the outer side (Fig. 1351); slit from the upper border of the aponeurosis from the internal pillar outward and sever as before a similar slip (Fig. 1351); tie to the free end of the upper slip a No. 3 silk thread armed with a needle and introduce the first suture (deep one) so as to unite the conjoined tendon and the lower fibers of the internal oblique and transversalis to the inner aspect of Poupart's ligament, raising up or not the cord as the case may be (Fig. 1352);

Fig. 1352.—McArthur's autoplastic suture. Deep suture uniting conjoined tendon and lower fibers of internal oblique to Poupart's ligament, cord raised. *A.* Aponeurosis of external oblique muscles. *I. O.* Internal oblique. *C. T.* Conjoined tendon. *T. S.* Tendon suture.

prepare as before and pass the second suture (superficial one) so as to unite the aponeurotic structures with each other, according to the plan of radical cure adopted (Fig. 1353); fasten the deep suture to the external oblique after the new internal ring is formed (Fig. 1354); fasten both sutures by knotting or by stitching, as seems best (Fig. 1354). The superficial tissues are closed in the usual manner.

The Remarks.—The cord is manipulated in that connection and the aponeurotic structures are arranged and fastened in accordance with the variety of the radical method of cure with which it is associated. These sutures become organized and remain a part of cure. Sometimes extreme thinness of the aponeurosis impairs the value of the sutures.

The Results.—McArthur reports 93 cases with commendable outcome.

77

Fig. 1353.—McArthur's autoplastic suture. Deep suture in place; superficial suturing begun. *A*. Aponeurosis of external oblique. *I. O.* Internal oblique. *T. F.* Transversalis fascia. *C.* Cord. *C. T.* Conjoined tendon. *T. S.* Tendon suture.

Fig. 1354.—McArthur's autoplastic suture. Superficial suturing nearly completed. Deep suture fastened. *A*. Aponeurosis of external oblique. *I. O.* Internal oblique. *T. S.* Tendon suture.

1156

Femoral Hernia.—*Bassini's Method for Radical Cure.*—Make an incision over the tumor parallel with and half an inch below Poupart's ligament down upon the sac; isolate the sac from the surrrounding tissues and from the femoral canal (Fig. 1355) as high up as possible; examine and reduce the contents of the sac and draw it forcibly downward; transfix the neck of the sac, and tie it in halves with a strong silk ligature; cut off the sac close to the ligature and permit the stump to disappear upward into the abdominal cavity; unite Poupart's ligament and the falciform process, at the outer side with the pectineal fascia and at the inner with the pubic portion of the fascia lata, with five or six silk sutures carried through the respective borders of these tissues and tied (Fig. 1355). The cutaneous incision is closed in the usual manner without drainage.

The Comments.—The upper first three stitches unite Poupart's ligament with the pectineal fascia; the second three the pubic portion of the fascia lata with the falciform process of the iliac portion, thus closing the lower end of the femoral canal by apposition of its anterior and posterior borders.

Coley, as advised by Cushing, closes the canal by means of the purse-string suture (Fig. 1356) passed in the following manner; Carry by means

FIG. 1355.—Operation for the radical cure of femoral hernia, Bassini's method. *a.* Falciform process. *b.* Pubic portion of fascia lata. *c.* Poupart's ligament.

of a curved needle a ligature of kangaroo tendon around and close to the wall of the canal, passing through the inner and upper part of Poupart's ligament, the pectineal fascia and superficial fibers of the pectineus muscle behind the canal, the fascia lata overlying the vessels, and finally through Poupart's ligament about a quarter of an inch from the point of beginning. The sac should be completely freed and the stump allowed to recede far upward before the ligature is tied. Carefully avoid the femoral vein.

The Results.—Bassini reports 54 cases with no mortality, of which 41 remained cured from one to nine years. Coley reports 82 cases treated by the purse-string method, with no deaths, and with but one relapse. Coley advises Bassini's method of closure if the femoral ring be very large, and reports 16 cases with one relapse.

as possible of the septum crurale and subperitoneal fat about the abdominal orifice of the femoral canal, carefully avoiding the femoral vein; draw down the sac by means of the clamp, thus exposing that structure at the highest point, to which a narrow-bladed clamp is applied; transfix and tie or divide and sew (as time permits) the neck of the sac above the clamp and sever the neck and permit the united borders to recede into the abdominal cavity; introduce the finger into the femoral canal and press inward, thus revealing the sharp resisting outer border of Gimbernat's ligament; make an incision two inches in length three quarters of an inch above Poupart's ligament, through the aponeurosis of the external oblique in the direction of its fibers, the center corresponding to the outer border of Gimbernat's ligament; draw apart the borders of the incision of the aponeurosis and separate from Poupart's ligament with the handle of the scalpel the underlying tissues corresponding to the incision in the aponeurosis; thread a stout, full-curved needle with fine, strong, chromicized catgut; introduce the finger into the opening and palpate outward to note the site of the deep epigastric artery, and place the first suture next to the vessel; introduce the needle through the opening in the aponeurosis and pass it successively through the internal oblique and transversalis muscles; push (at this time)
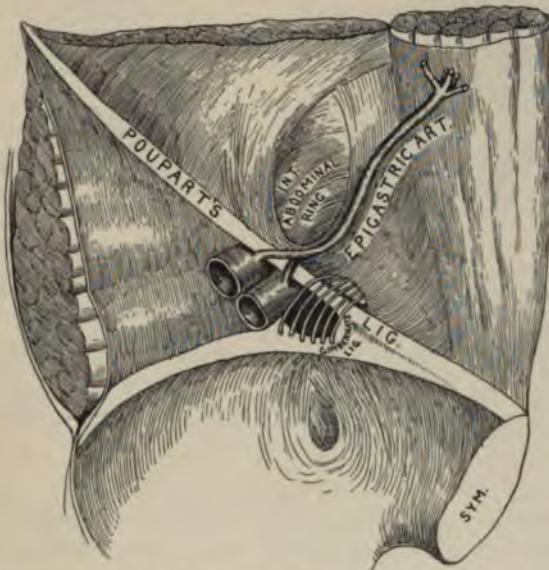
Fig. 1357.—Operation for the radical cure of femoral hernia, Gordon's method. Passing the sutures.

the peritonæum back out of the way and cause the needle to dip into the true pelvis, thence pass forward toward the saphenous opening, piercing the posterior layer of the femoral sheath, the pectineal fascia, the extension of Gimbernat's ligament (close to the bone), the pectineus muscle, and emerging through the floor of the saphenous opening on a level with the lower edge of Poupart's ligament; cause the needle to re-enter close to where it

emerged and to pass backward parallel with the previous course in a reverse manner through the same tissues, and escaping at the aponeurotic opening; pass two or three (as needed) sutures in a similar manner, the last one invading the border of Gimbernat's ligament (Fig. 1357), tie each carefully, bringing the internal oblique and transversalis muscles and other included tissues firmly into place, thus obliterating the mouth and upper portion of the femoral canal (Fig. 1357), then cut off the ends of the sutures; reinforce the preceding sutures by a single row of a similar number introduced superficially at points corresponding to the first, each including the lower border of the internal oblique muscle, and the pectineus muscle and fascia; tie each suture, thus obliterating the entire femoral canal
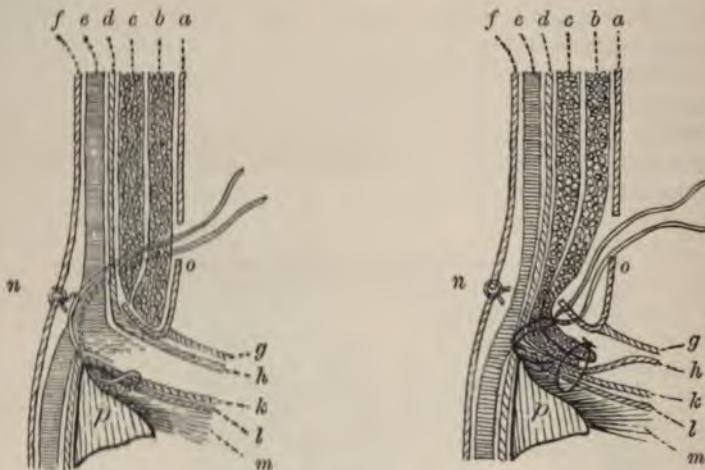
FIG. 1358.—Operation for radical cure of femoral hernia, Gordon's method. Transverse section showing relation of tissues. *a.* The aponeurosis of external oblique muscle. *b.* The internal oblique muscle. *c.* The transversalis muscle. *d.* The transversalis fascia. *e.* The subserous tissue. *f.* The peritonæum. *g.* The fascia lata superficial layer. *h.* Anterior wall of femoral sheath, i. e., extension of transversalis fascia. *k.* The posterior wall of the femoral sheath, i. e., extension of the pelvic fascia. *l.* The deep layer of the fascia lata, i. e., pectineal fascia in the pectineus muscle. *n.* The former neck of sac tied or sutured. *o.* The gap in the external oblique aponeurosis. *p.* The pubic bone.

(Fig. 1358); close the incision in the aponeurosis with a fine continuous catgut suture and the skin incision with interrupted silkworm gut.

The Remarks.—Avoid the epigastric artery, which is especially exposed to dangers in hernias with large necks. Anchor each deep suture by passing it through the fibrous band (Cooper's ligament) surmounting the pectineal line (Fig. 1357).

The Comments.—Avoid puncture of the femoral vein in sewing, to obviate both hæmorrhage and thrombosis. *Bottini* united the margins of the crural canal to Gimbernat's ligament; *Lowenstein* united the falciform process to the same ligament. The periosteal flap closures of Trendelenburg and others are ingenious conceptions, but are hardly warranted in the presence of the simpler and the efficient methods of Bassini, Coley, and others.

Umbilical Hernia (*Radical Cure*).—Two methods of procedure are commended for the radical cure of umbilical hernia: 1, the reduction of the contents and the freshening and suture with each other of the respective tissues, as in closure of abdominal wounds and the treatment of ventral hernia; 2, the transposition of tissue with the object of strengthening the median line. *In the first method* (*Greig Smith*) under strict asepsis open the cutaneous coverings from top to bottom (Fig. 1322); make a small incision at the thinnest part into the sac, cautiously shunning the bowel (*b*); divide the sac with scissors, guided by the fingers, carefully avoiding the omentum (*c*); return the bowel into the cavity, overcoming the opposing adhesions by separation, ligation, or cutting, as seems best; introduce an anchored sponge or wiper (Fig. 73, vol. i) into the umbilical opening to prevent the entrance of blood to the abdomen during the dissection; ligature and divide the omentum where it passes through the umbilicus (*i*, *j*), and return the stump to the abdomen; remove the herniated omentum along with the sac, without separating the adhesions; remove the superfluous integuments and sac down to the circumference of the opening; strip the peritonæum from around the umbilical opening (*i*, *j*) and push it into the abdomen; liberate the adjacent borders of the recti muscles by free separation of the margins of the ring; insert

FIG. 1359.—Operation for the radical cure of umbilical hernia, Greig Smith's method. A. Transverse section through hernia. *a*, *d*. Superfluous skin and sac, the former removed on the outer, the latter on the inner aspect of the tumor. *b*. Intestine. *c*. Omentum. *e*. Integument. *f*. Superficial and deep fasciæ. *g*. Muscles. *h*. Peritonæum. *i*, *j*. Incisions upon recti muscles made through fascia surrounding ring. Dotted lines between *a*, *i* and *d*, *j* indicate the course of separation of the sac. B. Superfluous tissue removed, bowel returned, omentum and sac taken away, and sutures *a*, *d* inserted. *i*, *j*. Structures around the ring opened and sutures applied. Other references same as in A. C. Suturing completed. D. Bird's-eye view of wound, sutures inserted for tying.

deep sutures through the structures down to the peritonæum as indicated (*a*, *d* and *i*, *j*, B and C); remove the wipers from the abdomen, tie the sutures firmly, and cut short the ends; introduce between the intervals of the preceding sutures the superficial ones (*a*, *b*), and tie as indicated in C. The wound is then dressed in the usual manner.

In *Boeckel's method* the sac is isolated and the umbilicus excised through

an elliptical incision of sufficient dimensions to meet the demands of the case; the sac is opened, intestine restored, and omentum returned or removed as seems essential to success; the borders of the base of the sac are joined with chain sutures, the sac is resected, and the stump turned inward; the fibrous borders are freshened even to the muscular structures of the recti, if need be. The peritoneal, fascial, fibro-muscular, and cutaneous tissues are united in turn from below upward with silver, kangaroo-tendon, or chromicized-catgut sutures, the last series being of silkworm gut.

Mayo's Method.—Mayo practices overlapping from side to side, also from above downward. He regards the latter as the better operation.

The Operation.—Make a transverse elliptical incision around the hernia, carrying it in a conoidal form down to the base of the protrusion; dissect clear the aponeurotic structures for two and a half to three inches in all directions from the neck of the sac (Fig. 1360); divide the fibrous and

Fig. 1360.—Operation for the radical cure of umbilical hernia, Mayo's method. Exposing neck of sac.

the peritoneal coverings of the hernia in a circular manner at the neck of the sac, exposing the contents; separate and restore intestines to the abdominal cavity; ligature and remove omentum along with the sac; make a transverse incision at each side of the opening an inch in length through the aponeurotic and peritoneal structures; separate the peritonæum from the under surface of the upper flap; pass through the border of the lower flap three or four mattress sutures and carry the ends through the upper flap (Fig. 1361) two and a half or three inches above its margin; make sufficient traction on these sutures to permit approximation and continuous suturing of the divided peritoneal borders; draw the sutures into position causing the lower flap to pass upward into the pocket formed by the aponeurosis and peritonæum; unite the free margin of the upper flap by catgut

sutures to the anterior surface of the aponeurosis below, and close the superficial incision in the usual manner (Fig. 1362).
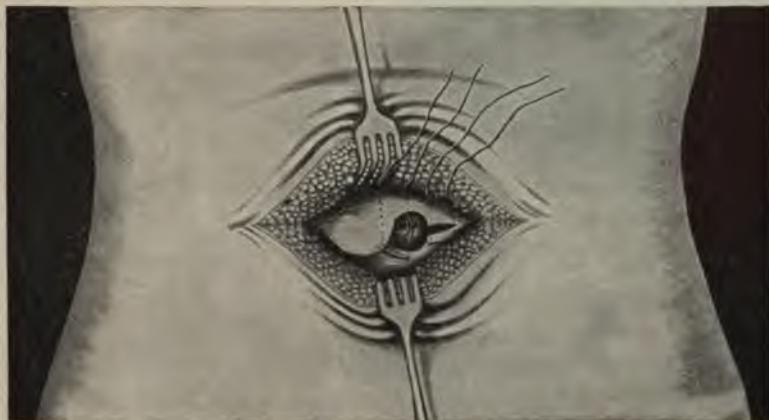
FIG. 1361.—Operation for the radical cure of umbilical hernia, Mayo's method. Placing sutures for closing transverse incision.

The Remarks.—In large hernias, the incision through the fibrous covering should be made above the opening to provide an increased amount of tissue for overlapping. In large irreducible hernias the patient should be kept in bed before operation on a low diet and directed to practice manipulation to reduce the size by restoring as much as possible of the contents of the sac. The removal of omentum from the abdominal cavity fits it the
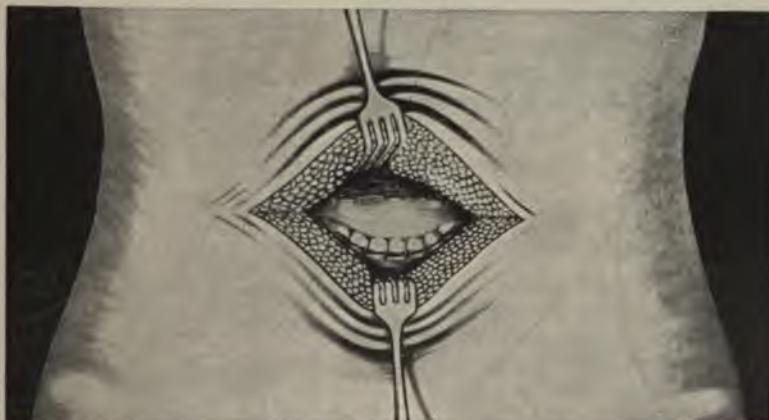
FIG. 1362.—Operation for the radical cure of umbilical hernia, Mayo's method. Aponeurotic opening closed.   Sewing of superficial wound to follow.

better for fitting restoration of long displaced intestines. The patients ought to remain in bed for four weeks after operation. The wearing of trusses should not be permitted, only abdominal supporters are serviceable.

Mayo reports 10 operations by overlapping from side to side and 25 from above downward with no deaths and no complete return.

Blake's Method.—Blake's method is essentially one of transference of tissue and is fitted for the treatment of major and minor cases. It is proper to state in this connection that strangulated umbilical hernia is more dangerous than either the femoral or inguinal variety.

The Operation.—Make an elliptical incision of varying dimensions (according to size of protrusion) around the hernia, down to the aponeurosis of the abdominal muscles; dissect free and raise up the elliptical area at all aspects of the borders of the hernial opening; open the sac, separate and return the intestine; ligature and remove omentum and open into the peritoneal cavity two or (according to the size of the hernial ring and relaxation of the walls) more inches above and below the hernial ring in the median line; separate the peritonæum for two or three inches at either side of the line of division (more on the left than on the right side) and suture the peritonæum in the median line; remove all fatty tissue from the anterior surface at the right of the incision; introduce chromicized catgut mattress sutures three quarters of an inch apart and a third of an inch from the border of the right half of the exposed area; carry these sutures two or more inches (according to relaxation) from the left border through the left rectus and its sheath; draw the right side beneath the left and hold the parts in place by tying the mattress sutures firmly on the anterior surface (Fig. 1363); suture the free edge of the left border to the anterior surface of the sheath of the right rectus; close the remaining incision with interrupted silkworm-gut sutures.
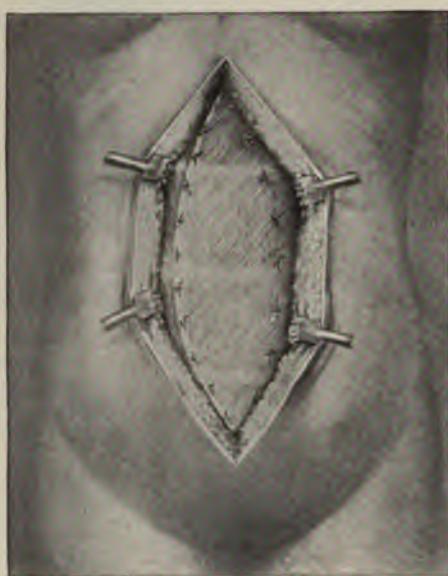
Fig. 1363.—Operation for the radical cure of umbilical hernia, Blake's method. Flaps in place.

The Comments.—Scraping the peritoneal surface of the left side may be practiced instead of separating and sewing the peritonæum as before, when haste is demanded.

The General Results.—The reported results from the independent union of freshened borders of selected tissues are excellent. In 300 cases 265 cures and 35 deaths are reported, a mortality rate of nearly 12 per cent (Boeckel). Of these, 105 were strangulated and 195 non-strangulated, with a death rate of 30.5 and 1.95 per cent respectively. Relapse occurs more frequently in these than in radical cure of inguinal hernia. The re-

sults of the experience of Bull and Coley and of the writer are not so favorable as the preceding appear to be, and the differences in the operative technique are hardly sufficient to account for the difference.

Ventral Hernia (*Radical Cure*).—Ventral hernia usually occurs in the median line, and is a common sequel of median cœliotomy. It also happens at other situations of the abdomen from operative practice. *Greig Smith* advised the separation of the areolar tissue between the skin and peritonæum (Fig. 1364) by means of the finger or curved scissors inserted through a small opening made along the main direction of the hernia. The superfluous skin is removed, the unopened peritoneal sac turned inward, and if abundant, united with a continuous suture carried through the areolar tissue. If of less amount it may be included by the suture closing the pari-
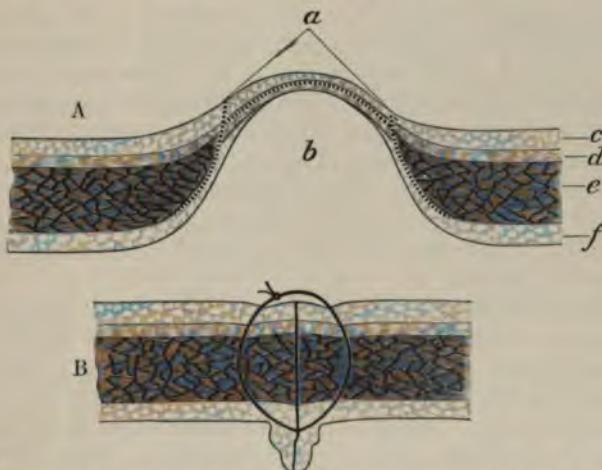
FIG. 1364.—Operation for the radical cure of ventral hernia, Greig Smith's method. A. Transverse section of ventral hernia. *a.* Stem between dotted lines to be removed. *b.* Hernial pouch. *c.* Integument. *d.* Fascia. *e.* Muscles. *f.* Fascia and peritonæum. Lines of incision indicated by dotted lines. B. Redundant stem removed, peritonæum turned in, and wound closed.

etal incision. Healthy muscular structure is freely exposed by dissection, and the borders are united by suture *en masse* as noted in Fig. 1364.

The Remarks.—The abdomen is not opened in this procedure; broad muscular surfaces are apposed and the inturned sac contributes a fenderlike opposition to intestinal pressure. Muscular tissue should be brought in contact at the line of union even if the detachment of separate bundles be required for the purpose, to insure firmer union.

Hernia following Appendicitis.—This infliction frequently follows free incisions in suppurating cases of appendicitis. In the earlier history of operative practice it happened in ten to fifteen per cent of the instances. In curing the infliction *Coley* advises free excision of all the cicatricial tissue, careful dissection and exposure of the internal and external oblique muscular planes, with separate suture of each with kangaroo tendon.

The Results.—The results of operation for radical cure of ventral hernia

are much less favorable and the fatality is greater than in similar procedures for the inguinal and femoral kinds. Up to 1898 *Bull* and *Coley* had operated for radical cure in 19 umbilical and 15 ventral herniæ. Of the latter, 11 followed laparotomy and 4 open-wound treatment of suppurative appendicitis.

Lateral ventral hernia is rare, and makes its appearance at Petit's triangle. Of 29 cases collected by Braun, 20 were congenital, or developed spontaneously, and 9 had a history of traumatism. This form has not yet been investigated sufficiently to enable one to lay a special method of practice for cure or for relief of strangulation. The general indications of treatment in the other forms have equal force in this.

Cæcal Hernia.—The presence of the entire or a portion of the cæcum in a hernial sac happens in about four per cent of the cases of hernia in the inguinal region. Rarely indeed is it that the cæcum is not partly or wholly covered with peritonæum. Cæcal hernia happens four times oftener at the right than the left inguinal region, and is five times more frequent at the right than the left femoral region. The presence in the sac of the cæcum is rarely known until the contents are exposed by incision. If covered with peritonæum, the cæcum is readily reduced; but, if partially or entirely uncovered, the return is often difficult, owing to the contact of non-serous surfaces; still, patient and careful manipulations will secure a return of the viscus, after which the operative technique is similar to that of the simpler forms of hernia.

Hernia of the Bladder.—Hernia of the bladder is not infrequent, and is chiefly dangerous because of the liability of cutting into it before recognition. Gibson reports 103 cases in which the bladder was wounded in 67, and uninjured in 36. The bladder may be intraperitoneal or extraperitoneal, sometimes both. It is mistaken for the primary or a secondary hernial sac; for cystic tumor and fatty accumulations. When its presence is suspected, the employment of a hypodermic needle or the introduction of a sound to the bladder should promptly settle the matter. The return of the viscus to the abdomen is not especially difficult. The wound of the bladder is closed and the patient treated in other respects as is usual in such wounds (page 1312).

The Results.—The rate of mortality is about twelve and a half per cent (Gibson).

Local Anæsthesia in Operations on Hernia.—The employment of local anæsthesia in the relief of strangulated hernia and for radical cure, especially when old age and organic infirmity forbid the use of general anæsthesia, has been brought prominently into view by *Cushing*, of Baltimore. Operations, relating to the abdominal contents, of even greater significance than hernia have been satisfactorily practiced with local anæsthesia. *Infiltration anæsthesia* with the second solution of Schleich (page 38, vol. i) has proved satisfactory. The basis of the utility of the plan rests on the fact that the cocainization of the trunks of sensation nerves renders anæsthetic the field of their supply. The location of the primary incision and of the nerve trunks subsequently dissected and their areas of supply, though well demonstrated by the illustration (Fig. 1365), should be carefully studied

before operation to determine their comparative relations with each other. The importance of the detail of the procedure is so pronounced that we beg to quote in full the description of Cushing:

"*Steps of the Operation.*—Individuals advanced in years are usually kept in bed for a day or two preliminary to the operation, to give an indication of their ability to endure recumbency, and for the purpose of training
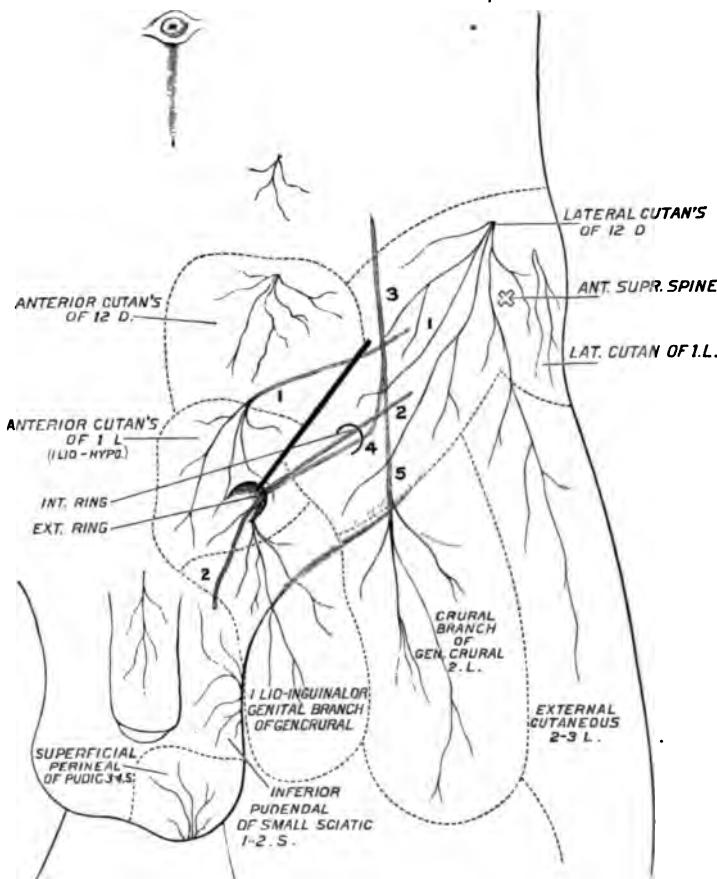
FIG. 1365.—Operation for the radical cure of inguinal hernia under local anæsthesia, Cushing's method. The peripheral distribution, and the relation of the trunks of the inguino-scrotal nerves to the main incision. 1. Ilio-hypogastric nerve. 2. Ilio-inguinal nerve. 3. Genito-crural nerve, its genital (4) and crural (5) branches.

them to void their urine in this position. Evacuation of the bladder is usually accomplished by the aid of an enema if any postural difficulty is experienced.

" It has been the custom to administer hypodermically a tenth or an eighth of a grain of morphin three quarters of an hour before, and to repeat this shortly before the operation. Ceci has emphasized the efficiency of this morphin-cocain combination, and I have found it most satisfactory.

The drug must be used with caution, however, since occasionally even small doses of morphin in old people may confine the bowels and lead to distention, which may be troublesome. Similarly, in old people with tardy bladders, it may inhibit the proper evacuation of the urine, though we have never had the misfortune to observe this.

" Patients past middle age also are usually shaved and prepared on the operating table to avoid any exposure incidental to an open ward preparation. The skin in the line of proposed incision is infiltrated with Schleich's cocain solution, and the incision may be immediately made through the linear wheal thus produced. It is common experience to find the infiltrated tissues more vascular than usual, and it is important that all bleed-
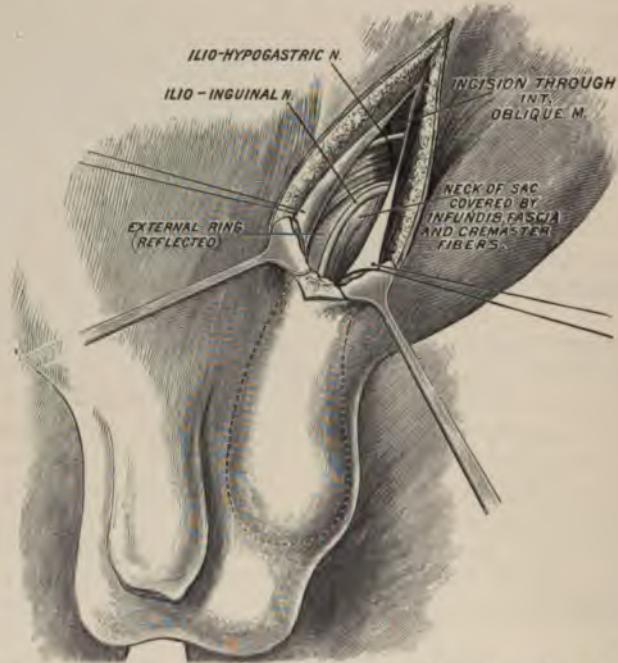
Fig. 1366.—Operation for the radical cure of inguinal hernia under local anæsthesia, Cushing's method.

ing points be immediately clamped, since a dry and unstained field is essential to the success of the dissection. It is unnecessary and useless to attempt to anæsthetize the panniculus. As Schleich has shown, only tissues which can be ' œdematized ' are fitted for the infiltration method, and in the panniculus, at the upper angle, practically no nerves are encountered. If, however, throughout its whole length, this incision is carried down to the aponeurosis, unanæsthetized fibers of the ilio-hypogastric will be encountered in the superficial fat at the lower angle, together with one or two large veins, division of which is painful, so that anæsthetization of the panniculus layer is here necessary, or else, as has been done on several occasions, the incision only at the upper angle may be carried down to the aponeurosis, which is

then opened in the line of fibers from the external ring, and the ilio-hypogastric and inguinal nerves immediately cocainized with a one-per-cent solution as they lie under it. After this procedure the lower angle of the incision may be painlessly carried down to the external ring, and the remaining intercolumnar fibers of the aponeurotic insertion divided. Reflection of the pillars of the ring gives the view shown in the accompanying sketch (Fig. 1366). In the Halsted operation at this stage the internal oblique fibers are divided, preliminary cocainization of the edge of the muscle being necessary for the reasons given above. There is, under ordinary circumstances, no further need of the anæsthetic, as we are working in an area freed from all sensation. The combined ilio-inguinal and genital branch, which has been cocainized at the outer limit of its exposure, is now reflected to one side or the other, care being taken not to divide it, since this leads apparently to a more or less permanent paralysis of the cremaster, which is to be avoided. I believe the accidental division of this nerve leads to the great relaxation of the scrotum so often seen after hernia and varicocele operations. In the latter operation, especially, it would be detrimental to the best interests of a successful result to interfere with the cremasteric function in any way. The remainder of the operation—the exposure of the sac and cord after a longitudinal division of the infundibuliform fascia, the amputation of the sac at its neck and closure of the peritoneal opening, the excision of the fundus of the sac,.division of the cord, and castration, if deemed advisable—may now be done practically without pain. Occasionally, however, some stray fibers of the genito-crural may be encountered about the neck of the sac, and also during castration I have found that ligation of the veins at the lower pole of the testicle may be painful, though division of the cord above is not. Possibly the superficial perineal branches which have been unanæsthetized furnish nerves to this lower blood supply."

The Remarks.—Those patients who bear slight pain badly, those in whom the inhibiting influence of the drug is rapidly exhausted, and those with strong imaginations, may require the aid of a little morphin, and perhaps now and then a few breaths of chloroform. A careful study should be made of the course and supply of the sensitive nerves involved in the operation before attempting the procedure, to avoid direct injury of them, also to lessen needless infliction of pain. Anæsthesia of individual trunks and their areas of distribution is secured by direct injection into the trunks of a half of one-per-cent solution of cocain.

Handling and repair of healthy intestine do not cause especial pain, therefore local anæsthesia is not needed. However, the manipulation of strangulated and diseased intestine causes referred pain, usually to the epigastrium. Sterilization of food and aseptic treatment of the mouth decidedly lessens the putrefactive changes of intestinal torpors and obstruction.

The Results.—Twenty-five cases of operation for radical cure are reported; 6 were strangulated, of which 1 died; the remaining 19 recovered. Thirteen of the entire number were above sixty years of age, 7 of which were seventy and over. The experience of greater opportunity and of extended application establishes this plan of action on a still firmer basis than it before possessed.

of the anal opening and of the contiguous integument, the condition of the blood-vessels about the opening, and the white line at the muco-cutaneous junction, corresponding to the interval be-tween the internal and external sphincters, should be noticed. The degree of sphincteric contraction, and the irritability of the patient, as evidenced by the introduc-tion of the finger into the anus, are important items relating to cure. For a general inspection of the anal canal the sphincterscope of Kelly (Fig. 1194, *e*) is very serviceable, especially for a view of internal hæm-orrhoids; or a bivalve speculum is useful where the re-dundant mucous folds must be separated to expose a localized lesion, as a fissure or small ulcer. The Pratt (Fig. 1385) & Leonard (Fig. 1386) specula are good examples of the latter sort. The Leonard speculum being small is particularly adapted for the examina-tion of a sensitive patient. Thorough cleansing of the bowel, and the final escape of the fluids employed for this purpose, should be secured before any special attempt is made to examine the anus or rectum.

Imperforate Anus.—Imperforate anus is character-ized by a layer of tissue of variable thickness which exists between the normal site of the external opening and the lower extremity of the rectum. It may be simply

FIG. 1368.—Rectal bougies. *a*. Cy-lindrical. *b*. Con-ical shaped.

a thin layer of fibro-cellular tissue, which, by projection, indicates the near-ness of the loaded bowel. In these cases the active emotions of the child may be noted by the movements of the interposed membrane, and a positive diagnosis can be made by a hypodermatic puncture. If the septum be thin, a longitudinal or crucial incision, or even a simple puncture, followed by

FIG. 1369.—Absence of anus.
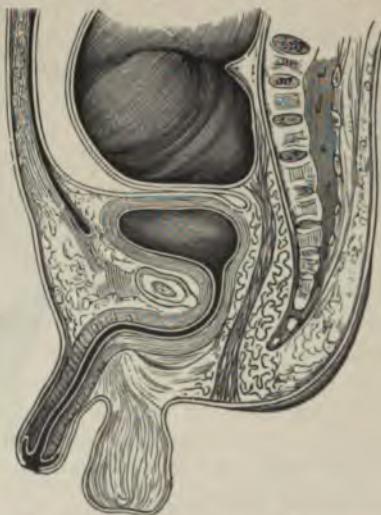
FIG. 1370.—Absence of anus and rectum.

78

the careful introduction of a well-oiled finger, will be a sufficient operative
interference, especially if afterward the extremity of a suitable sized rectal
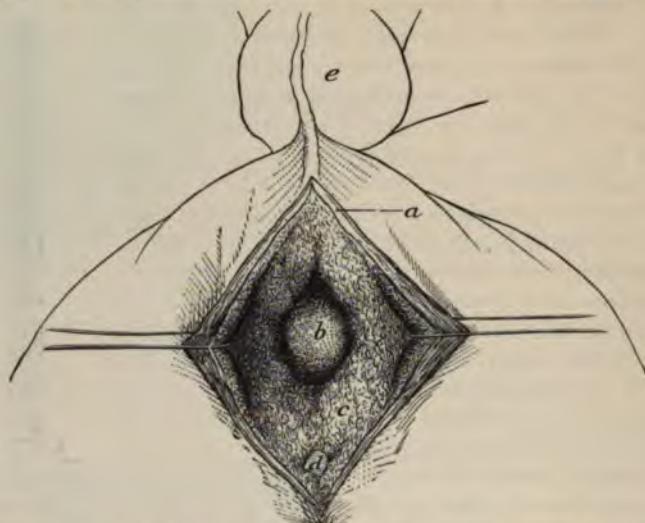
Fig. 1371.—Operation for absence of anus.   a. Border of cutaneous incision.   b. End
of bowel.   c. Perirectal tissue.   d. Extremity of coccyx.   e. Scrotum.

bougie be occasionally introduced (Fig. 1368).   If the membrane be of
sufficient density to interpose an obstacle after its division, it should be
trimmed away, care being taken not to include the structure proper of the
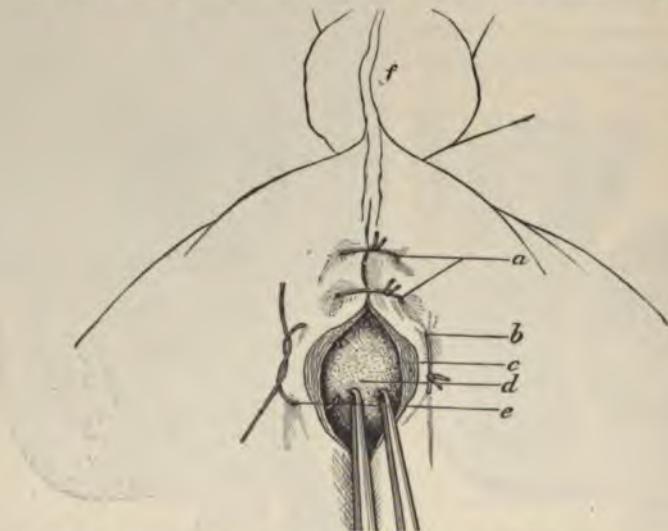
Fig. 1372.—Operation for absence of anus.   a. Sutures at anterior aspect of wound;
the posterior one may pass through the wall of the *cul-de-sac*.   b, e. Sutures at sides
of wound, both transfixing the wall of the *cul-de-sac*.   d. Rectal *cul-de-sac*.   f.
Scrotum.

opening. Severe and even fatal hæmorrhage has been known to follow these apparently trivial operative procedures.

Absence of the Anus (Fig. 1369).—In this deformity all trace of the opening is absent, and the median rhaphe may extend continuously from the scrotum to the tip of the coccyx. The fibro-cellular interval may be either thin or of extreme thickness. If thin, the previously detailed signs of imperforate anus may be evident. When, however, they are not present, the occlusion is of considerable thickness, and may even involve the entire length of the rectum itself (Fig. 1370). In the latter instance the sphincter is sometimes wanting. The rectal pouch may hang loosely in the pelvic or abdominal cavity, or be attached to some contiguous structure. A distinct fibrous band may lead from the skin to the rectal pouch, or only cellular tissue may intervene.

The operation for relief consists in first placing the patient, properly anæsthetized, in the dorsal position with the pelvis elevated. Then intro-
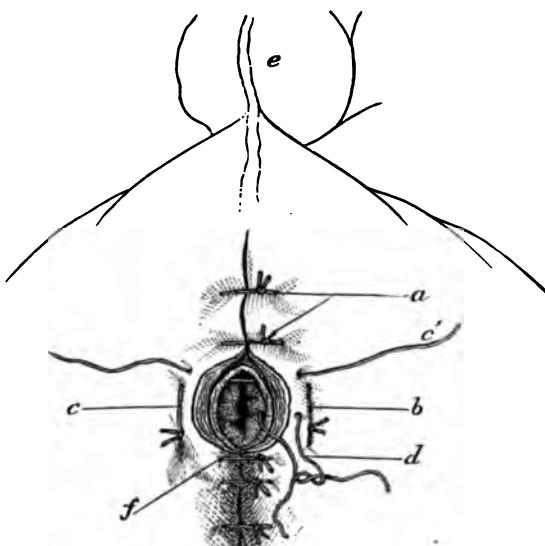
FIG. 1373.—Operation for absence of anus. *a.* Primary anterior sutures. *b, c.* Lateral sutures tied. *f, c'.* Anterior and posterior sutures transfixing wall of gut. *d.* Example of suture of gut to border of wound.

duce a sound into the bladder if the patient be a male, or into the vagina if a female, and make a vertical incision in the median line from just behind the scrotum or vagina, as the case may be, to the tip of the coccyx (Fig. 1371); deepen it cautiously up and backward, shortening each succeeding cut, and carefully feel for the fluctuating extremity of the gut. The latter is sometimes located posterior to the central line, and must be sought for near the hollow of the sacrum. During the entire progress of the dissection the situation of the vagina or urethra must be marked by the location of the sound previously introduced. When the dark-brown, fluctuating extremity of the gut is detected, the introduction of a hypodermic needle

PAQUELIN'S CAUTERY.

Fig. 1374.—Instruments employed in operations on the anus.

a. Scalpels.　*b*. Bistouries.　*c*. Forcipressure.　*d*. Speculum.　*e*. Rubber tube mounted with gauze for introduction into the anus and rectum.　*f*. Dissecting and mouse-tooth forceps.　*h*. Strong hook forceps.　*i*. Grooved director.　*j*. Blunt retractor. *k*. Pile forceps, Kelsey's.　*l*. Needle holder.　*m*. Long-nosed clamp forceps.　*n*. Scoop.　*o*. Sponge holder.　*p*. Tenaculum.　*q*. Pile clamp.　*r*. Silver probe.　*s*. Curved and straight scissors.　*t*. Ligatures armed with needles.　*u*. Chromicized catgut and silkworm gut.　*v*. Long and short needles.　Sponges, wipers, and ligatures are required.

will settle all doubt. The gut end should then be seized by a strong, toothed forceps (Fig. 1372), and drawn firmly downward, while its connections with the surrounding tissues are separated by the scissors and fingers. As soon as the *cul-de-sac* is drawn down to a level with the external opening, two short ligatures are passed transversely through the sides of the wound (*b, e*), or through its anterior and posterior extremities, transfixing in either instance the walls of the bowel in their passage, but not entering the lumen of the gut. Protect the raw surfaces with lint saturated with carbolized oil, then open the sac between the ligatures and allow the contents to escape; after having thoroughly cleansed the parts, remove the lint and unite the border of the sac with the anus by interrupted silkworm-gut sutures (Fig. 1373). Cleanse the bowel thoroughly, and introduce a small, coaptating plug of iodoform gauze perforated by a good-sized rubber tube (Fig. 1374, *e*) to exclude fæcal matter from the line of sewing, and to permit the escape of intestinal gases at the same time. The mucous membrane should be closely adjusted to the integument, in order to secure perfect union and prevent the contact of the raw surfaces with the discharges. If it be impossible to draw the end of the gut down to the external opening, it can be incised at its lower extremity, and the discharges allowed to escape over the lower surfaces, which are kept open by the use of the bougies; or the coccyx can be removed, as recommended by *Verneuil*, and the extremity of the bowel drawn through the gap and united to the integument as before.

The Remarks.—The usual distance between the pouch and the perinæum is about two inches, and the site can be well located by the occasional introduction of the hypodermic syringe. Fatal cellulitis may follow the dissection directly or from the efforts to maintain the patency of the new canal (Fig. 1373).

Fistula in Ano.—A fistula here, as elsewhere, is a sinus, which in this case leads into the cavity of an abscess located near to the rectum. It may be either complete or incomplete; if of the latter variety, it may be an incomplete internal or external fistula (Fig. 1375). The complete form (*b*) is the more frequent. In either variety the openings are usually situated within an inch or less of the

Fig. 1375.—*a*. Anus. *r*. Rectum. *b*. Complete fistula. *c*. Incomplete internal fistula. *d*. Incomplete external fistula.

anus. These fistulæ are of devious shapes and of varying extent, the horseshoe variety (page 1180) often being very perplexing.

The Anatomical Points.—A fibro-aponeurotic layer extending around the whole circumference of the bowel separates the internal from the external sphincter. Above, this layer is continuous with the recto-vesical fascia. On its outer surface, at the upper limit of the anal canal, it receives laterally and posteriorly fibers of insertion from the levator ani, and on its inner surface it receives the terminal fibers of the longitudinal coat of the rectum. This layer is of importance in determining the course of pus

extravasation. In posterior horseshoe fistula the channel of communication between the lateral tracts is located in the fibro-cellular interval between the posterior fibers of the external sphincter and the levator ani. The external sphincter receives anteriorly and laterally branches from the internal pudic nerves arising from the third and fourth sacral roots, and posteriorly branches from the fourth sacral nerves. These latter branches enter the posterior portion of the external sphincter on either side near the median line, so that *Goodsall* and *Miles* advise never dividing the external sphincter near the median line posteriorly for fear of cutting the nerves, but instead at the middle of the postero-lateral quadrant of the anus. The nerve supply of the internal sphincter is from the sympathetic system.

The Examination for the Detection of a Fistulous Opening.—Evacuate the bowel by a cathartic and an enema; place the patient on the back or side, and introduce the well-oiled index finger of the hand corresponding to the side of the patient presenting the external opening into the rectum. The careful movement of the end of the finger over the mucous membrane will often detect a nipple-like projection indicating the internal opening. If a *flexible* probe be introduced through the external opening, it can, with a little care, be carried into the lumen of the rectum. Sometimes, however, the end of the probe will be felt separated from the finger by only the thin mucous lining of the gut; this may be due to the inability to find the internal opening or to its non-
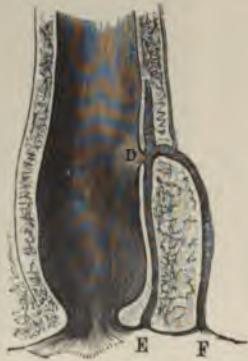
FIG. 1376.—Fistula in ano with dual
openings (F, E).

FIG. 1377.—Fistula in ano with extensive undermining of mucous membrane (I).

existence. If present, the internal opening should be found; if absent, in the case of a superficial fistula, the thin wall may be perforated by the instrument, thus producing a complete one. It not infrequently happens that more than one opening (F, E) communicates with the seat of the original abscess, D (Fig. 1376), and also that the mucous membrane is undermined to a considerable extent above a previously existing abscess (Fig. 1377, A).

The Remarks.—It is of importance to remember that the introduction of the finger or the probe often produces such a degree of contraction of the sphincter as to prevent the passage of the probe without great difficulty along the sinus into the gut; therefore the attempt to pass it should not be

made until the muscular contraction ceases. It may be advisable to paralyze the sphincter by overdistention before dividing the sinus; this causes the parts to remain at rest, adding to the comfort of the patient and hastening recovery. It can be best accomplished by inserting the thumbs or index fingers straight side by side and separating them, or by the use of a speculum designed for the purpose (Fig. 1379). Flexing the first joints in this procedure is liable to lac-

Fig. 1378.—A manner of paralyzing the sphincter we do not commend.

Fig. 1379.—Thebaud's dilating speculum.

erate the mucous membrane (Fig. 1378). A greater degree of distention attends antero-posterior stretching than lateral stretching.

The Operation Treatment.—*The accepted plan of treatment*—division of the walls of the sinus—can be accomplished by *direct incision*, by *ligature,* or by the *galvano-cautery.* The first method is commonly employed. For this purpose the bowel should be thoroughly evacuated by a brisk cathartic on the day preceding the operation, and a light diet should follow. On the day of the operation the bowel should be well cleansed by one or

Fig. 1380.—Operation for fistula in ano, shallow sinus. End of grooved director turned out through anus.

Fig. 1381.—Operation for fistula in ano, deep sinus. End of finger in contact with extremity of grooved director.

Fig. 1382.—Operation for fistula in ano. Piece of wood substituted for finger.

two copious enemata, which should have escaped before the operation is commenced.

The Operation by Direct Incision.—Place the patient on the back and give an anæsthetic; pass the finger into the bowel, as before described; introduce a grooved director through the sinus into the bowel; if the end of

the director can be turned out (Fig. 1380), divide the sinus upon this instrument; if not, press its end against the finger, and pass a probe-pointed bistoury along the groove into the bowel, after which the director may be withdrawn, the point of the bistoury pressed against the finger and
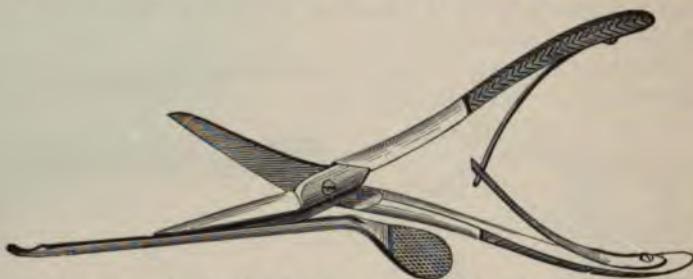
FIG. 1383.—Operation for fistula in ano.   Allingham's director and scissors.

the sinus cut outward with the point thus protected (Fig. 1381).   For the finger may be substituted a wooden director introduced into the bowel, by aid of which division is made (Fig. 1382).   The scissors may be employed instead of the knife, either with (Fig. 1383) or without the grooved director.   Either sphincter should be divided at right angles with the course of its fibers to avoid as far as possible the danger of incontinence of flatus and fæces.   When the internal and external opening of a fistula are

FIG. 1384.—The proper way to divide the sphincter,
i. e., transversely.

not directly opposite each other, Tuttle first opens the tract laterally, external to the sphincter until the fibers can be cut at right angles (Fig. 1384).

While each sinus should be opened, still, when possible to avoid it, the sphincter should not be divided at all; and, at all events, only at one situation at a time, in order that its integrity can be the better restored; when practicable, a small portion of the circular fibers should be preserved with the same object in view. A blind submucous pouch above the opening into the gut (Fig. 1377, I) should be laid freely open, best done with a cautery to control hæmorrhage, else it will not heal.   As soon as the sinuses are opened, their pseudo-membranous linings should be scraped with a scoop or touched with a thermo-cautery, all hæmorrhage stopped, the cut packed

with oakum, marine lint, or iodoformized gauze, a T-bandage applied, the patient placed in bed with limbs extended, and morphin or opium sparingly given to relieve all irritation and to produce passive constipation of the bowels. The wound is dressed once or twice daily, according to the demands of cleanliness, which should be strictly enforced. The food should be light, and not of a nature likely to leave a residue. In three or four days make use of a mild cathartic in conjunction with a copious enema to secure a fluid movement.

The Injection Treatment.—In the case of a complete fistula lying outside of the internal sphincter *Goodsall* and *Miles* advise against division of the internal sphincter for fear of resulting incontinence, and recommend instead the trial of injections of nitrate of silver, 60 grains to the ounce, protecting the mucous membrane of the bowel from the action of the caustic by means of olive oil, and the enlargement of the external opening for free drainage of the sinus. They repeat the injections, if necessary, three or four times at intervals of two or three weeks.

The Remarks.—If the caustic injection is finally unsuccessful, *Goodsall* and *Miles* still advise against division of the internal sphincter. In our

FIG. 1385.—The Pratt rectal speculum.   FIG. 1386.—The Leonard rectal speculum.

experience with this method we have been able to cause closure of the internal opening, thereby converting the complete into a blind external fistula, but we have been unable to completely close the sinus. A saturated salt solution can be used to neutralize the nitrate of silver as it enters the bowel, supplementing the protective action of the oil.

The Precautions.—Hæmorrhage of any importance is rarely seen—packing and ligature will readily control it; concealed hæmorrhage—i. e., free bleeding into the rectum—may be troublesome unless anticipated and

prevented. Rapid healing of the freshly cut surfaces without repair of the fistulous canal should be prevented, otherwise the original character of the affection will soon be restored. The separation of the borders of the wound with a small amount of gauze or by frequent introduction of the finger will prevent premature union and foster granulation of the fistulous tract. On the other hand, too frequent dressing or firm packing, and walking about, may delay and even defeat repair of the parts. The devious courses of fistulæ, *involving the external sphincter only*, should be followed and opened unless their course requires more than one division of the sphincter, when repeated operations at distinct intervals should be performed rather than imperil the sphincteric power by cutting all at a single sitting. Oblique division of the external sphincter may be followed by partial incontinence. It is always possible that even a *single division of the internal sphincter* may be followed by some loss of control of the bowel, so that when the division of this muscle is contemplated, the patient should always be informed beforehand of the possibility of the occurrence of the sequel.

FIG. 1387.—Fistula in ano, equilateral horseshoe form. Line of incision.

FIG. 1388.—Fistula in ano, equilateral horseshoe form. Line of incision.

FIG. 1389.—Fistula in ano, irregular horseshoe form. Line of incision.

The internal sphincter should likewise never be divided more than once at a sitting, and then after a distinct interval of time. *Tuttle* regards the

resulting incontinence following operations for fistulæ to be due generally not to division of the internal sphincter, but to oblique division of the external sphincter, or to complete division of the same attended with considerable retraction of the divided ends. *Quénu* and *Hartmann* recommend primary suture of the divided sphincter ends. A fistula in ano in tuberculosis often heals with difficulty and after much delay, especially if associated with local turberculosis or great depression from constitutional involvement. When operable, a tubercular fistula in ano should either be completely excised without slitting open the track and the wound sutured, or it should be laid open by means of the Paquelin cautery, the flabby granulations scraped away, and the base cauterized. In advanced pulmonary tuberculosis, a radical operation is contraindicated, and drainage only should be secured, the incision preferably made with a cautery.

The Comments.—The walls of fistulæ should be scraped after division to facilitate healing, and all gristly, undermined, and granulation tissue and complicating hæmorrhoids removed. The detection of a communication within is often difficult and even impossible except with the use of injections. The injection of milk, peroxide of hydrogen, or of a weak solution of iodine with

FIG. 1391.—Operation for fistula in ano. The probe as elastic ligature carrier.

FIG. 1390.—Allingham's rubber ligature carrier.

starched gauze in the rectum, will reveal the slightest communication with the bowel, unless the opening within is closed by needless pressure. One of the various forms of rectal speculæ may be of service in locating the opening (Figs. 1385 and 1386). Fistulæ vary much in their extent and relation to the gut. The horseshoe (Fig. 1387) variety has an opening within and one at either side of the anus without, a sinus communication existing between the outer openings, and both communicating with the inner one. The internal sinus should be slit up by an incision either in the posterior median line (Fig. 1388) or at right angles to the sphincter fibers (Fig. 1389). The curved sinus is then divided in either direction to the openings without involvement of the gut. Only one division into the gut should be made, unless more than one opening be

present there, and the openings be independent of each other. The second division should be made after an interval of time has intervened.

Goodsall and *Miles* recommend making the cut into the bowel dividing the sphincters, if necessary, some time subsequent to incising the lateral burrowings outside the bowel. They reason that if the internal opening is small it may close following simple drainage of the lateral burrowings. If, on the other hand, the track into the bowel does not close, they advise dividing it after the wound from the incision outside the bowel has nearly healed.

Direct Incision with Closure (S. Smith).—If the extent of the sinus will permit it, the entire track should be removed by dissection and the resulting wound closed by catgut sutures carried deep enough to bring the walls of the wound in contact with each other. The deep tissues should be brought together by a row of plain or of chromicized catgut sutures, the edges of the mucous membrane with plain catgut sewed on the inside of the bowel, and the skin edges with silkworm gut. In this manner union by first intention may be secured, thus shortening the period of recovery, and obviating all danger of fæcal incontinence dependent upon the incomplete closure, which sometimes occurs when the cut is deep and is permitted to heal from the bottom. If, however, there be a cavity remaining at the upper end of the sinus, or if any portion of the fistula be not dissected out, the recovery by rapid healing will be retarded if not entirely prevented. The author has carried into effect the proposition of prompt closure of the wound by sewing in repeated instances, and usually with success. In no instance has harm ever followed the attempt. Great care should be exercised to secure fluid movements at first to prevent undue strain on the lines of suture.

The Treatment by Ligature.—The elastic ligature is the only form worthy of consideration. The ligature consists of a rubber cord about one tenth of an inch in diameter. The cord is carried through the sinus into the gut by a special instrument (Fig. 1390), or by a long, large-eyed silver probe, so diverted as to escape at the anus (Fig. 1391), the inner extremity drawn out through the anus and the ends tied firmly together, after any integument which might be included in its grasp has been first divided, to prevent the pain and delay incident to the division of its peculiar structure by the constricting agent. The probe and a strong silk thread admirably meet the requirements, as the latter, after being passed through the sinus, may easily draw the rubber cord attached to it into position. It is sometimes difficult to tie a knot securely in the rubber cord. Still, this can be accomplished easily by tying the first half of the knot over a silk ligature placed at right angles to the course of the elastic one, and then tying the silk ligature firmly around the half knot. This holds the elastic cord securely while the knot of the rubber cord is completed. The elastic ligature will cut its way through in six or eight days.

This method possesses some advantages over that of incision, among which may be noted that, in simple cases, little or no pain is inflicted, and the patient can walk without any especial danger.

Timid patients refusing the use of the knife will often submit to the employment of the elastic ligature. The cure by ligature is not attended

with bleeding, which is an advantage when vessels of unusual size may be implicated, or when an undue tendency to hæmorrhage exists. It can be employed in all cases where but a single sinus exists; if, however, a second be present, the result must be of necessity unsatisfactory, as its employment then involves a repetition of the operation or the use of the knife.

The galvano-cautery (Fig. 109, vol. i) is employed for laying open a tubercular fistula (page 1181), and when danger of hæmorrhage is apprehended, as in opening a submucous track.

The Results.—The death rate is difficult to estimate, because of the comparative innocence, but at the worst it forms no significant product of the procedure. However, certain sequels of the operation are of special significance.

The important sequels of operation for fistula in ano are incontinence of fæces and gas, and prolapse of the mucous membrane and possibly of the bowel as well. Various reasons are assigned for the condition that permits of their occurrence. Females are more subject to incontinence than males.
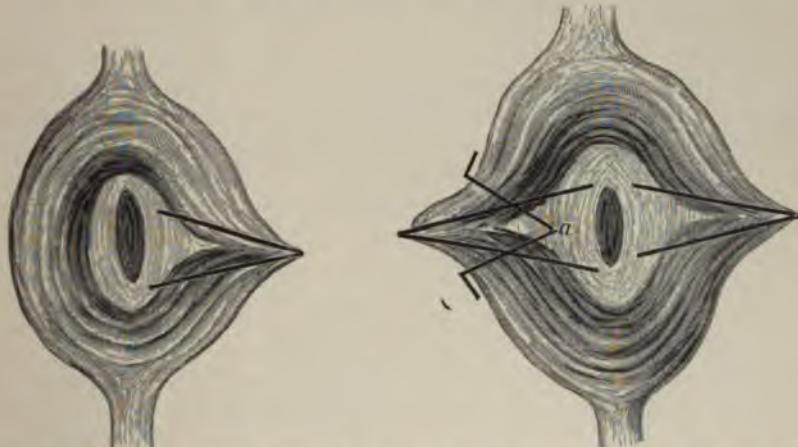
FIG. 1392.—Plastic operation for cure of incontinence of fæces, unilateral.

FIG. 1393.—Plastic operation for cure of incontinence of fæces, bilateral.

Repeated, oblique, and high division of the sphincter and division at the junction with the sphincter vaginæ should be avoided if possible because of their liability to cause incontinence. Often after ordinary operations several weeks are required before complete control of the sphincter is secured. Irrespective of the cause, the sequels are best obviated by a limited impairment of the sphincter, and close union and prompt healing of the divided ends at the time of operation. *Two methods of cure are recommended:* 1, the employment of plastic repair; 2, the use of the actual cautery. *In the former method* a V-shaped incision is made with the apex outward and with the lines of incision so directed as to expose the divided ends of the sphincter (Figs. 1392 and 1393), which are then freshened and drawn together by means of sutures passed deeply and retained in place during healing of the wound. The anal mucous membrane at the base of the triangle should not

be divided, as it serves to protect the severed tissues from infection. Especially is this true if the membrane be separated from the subjacent tissues and drawn down and stitched to the anal border at the seat of repair of the

Fig. 1394.—Operation by cauterization for cure of incontinence of fæces.

sphincter. *Tuttle* reverses the incisions (*a*) thus bringing directly together the divided ends. Vertical subcutaneous division of the inner fibers of the sphincter, at a little distance from either side of the line of union of the divided ends, will sometimes aid the final repair, by lessening the tension of the inner and shorter sphincteric fibers. The secondary divisions heal

A   B   C
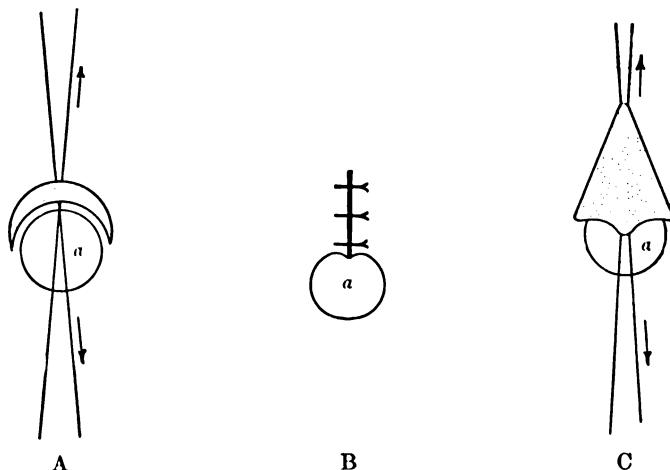
Fig. 1395.—The operation of repairing the sphincter ano, Robson's method.

promptly. *Mayo Robson* * has performed anoplasty for incontinence of fæces due to relaxed or paralyzed sphincter ani as follows: With the patient in the lithotomy position make a semilunar incision at the junction of the skin and mucous membrane around the anterior half of the anus (Fig.

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* The Practitioner, xvii, February, 1903, p. 175.

1395, A), and deepen it about one fourth to half an inch; separate the upper and lower margins by drawing them apart with forceps so as to make the semilunar slit into a lozenge-shaped cavity (Fig. 1395, C); close this cavity by bringing the sides together with buried catgut sutures, and the skin with silkworm-gut sutures (Fig. 1395, B). The wound is entirely external to the bowel. The operation diminishes the size of the anus and restores the power of the sphincter muscle. Robson says " the operation probably acts in one or both of two ways: (*a*) by shortening the sphincter muscle, thus enabling it to grip the anal orifice; or (*b*) by bringing together the torn ends of the muscle."

In the latter method, deep, outward radiating divisions are made with actual cautery, with or without linear cauterization of the mucous membrane of the lower end of the rectum, at points corresponding to the inner extremities of the radiating incisions (Fig. 1394). The radiating burns extend from within the anus outward for an inch, down to the sphincter. In any method of repair the anus and rectum should be kept as quiet as possible, and perfect cleanliness enforced. The many details of the technique of repair will be found only in treatises devoted especially to rectal disease.

Hæmorrhoids.—A varicose condition of the ano-rectal veins is a frequent affection, to which the term hæmorrhoids or piles is applied. *Two distinct varieties* of hæmorrhoids are recognized—external and internal hæmorrhoids. A combination of the two—intero-external—is not infrequently seen. The external are located without the bowel and are intimately connected with the anal border. The internal are located within the bowel and are not seen externally except when prolapsed. In either situation the growths vary in shape, size, and extent of attachment. External piles are usually globular, with a sessile or pedunculated base, and an inner mucous and outer cutaneous surface. Internal piles may be either pedunculated, sessile, columnar, etc., shaped according to the degree and extent of the dilatation. Prolapsus ani (Fig. 1415) sometimes attends the hæmorrhoids.

The Anatomical Points.—The lining membrane of the anal canal comprises a narrow zone of stratified epithelium three to nine millimeters (.12 to .35 inch) wide, which is transitional between skin and mucosa, called the pecten, the structure of which has been described by Stroud.* The nerve supply of the pecten is from the third and fourth sacral roots which gives to this area a special tactile sense to warn, when necessary, the voluntary sphincter, which is also supplied by branches from the third and fourth sacral roots, to contract. Therefore it is unadvisable in the removal of hæmorrhoids to take off any more of the pecten than is necessary. The lining of the anal canal above the pecten is mucous membrane which is arranged in longitudinal folds, five to seven in number, known as the columns of Morgagni. The superior hæmorrhoidal veins are the ones chiefly concerned in the formation of hæmorrhoids. Their course is longitudinal along the bowel, and they contain no valves, so that they are prone to con-

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* Annals of Surgery, xxiv, p. 2, 1896.

gest. *Quénu* and *Hartmann* describe them as arising from a submuco-cuta-
neous plexus beneath the valves of Morgagni and then forming venules
which ramify in the columns of Morgagni, whence they converge to form
ten or twelve trunks which remain in the submucous tissue until eight to
ten centimeters (3.1 to 3.9 inches) from the anus. These trunks then pierce
the muscular coat of the rectum and converge toward its posterior aspect,
uniting as they go, until they form a single trunk which enters into the
inferior mesenteric vein, thus joining the portal circulation. The middle
and inferior hæmorrhoidal veins enter the caval circulation. They are pro-
vided with valves and anastomose freely with the branches of the superior
hæmorrhoidal vein. The venules ramifying in the columns of Morgagni,
when they become varicose, form internal hæmorrhoids. They lie imbedded
in loose connective tissue and can be readily raised away from the internal
sphincter, which should be done in the removal of hæmorrhoids. The
veins at the anal margin are anastomotic vessels connecting the superior
hæmorrhoidal veins in the columns of Morgagni with the inferior hæmor-
rhoidal system of veins. They are the vessels concerned in the formation of
external hæmorrhoids. The terminal branches of the superior hæmorrhoidal
artery enter the columns of Morgagni longitudinally, parallel with the
veins, and are of importance in the removal of internal hæmorrhoids.

The preparatory treatment consists in securing a free evacuation of the
bowels twenty-four or thirty-six hours before operation, followed by a
sufficient number of enemata to thoroughly empty the bowel. Care should
be taken to eliminate from the rectum any retained fæces or fluid injection,
so as to avoid the unpleasant catastrophe and wound infection that might
happen from an unanticipated discharge during operation.

Various operative methods of treatment have been devised for cure of
hæmorrhoids, the most important of which are by: *a*, incision; *b*, excision;
c, ligature with excision; *d*, Mitchell's by clamp and suture; *e*, clamp and
cautery; and *f*, injection.

The Incision Method.—Incision is employed in the treatment of recent
inflamed and distended hæmorrhoids. After thorough cleansing of the
parts place the patient on the side, with the thighs flexed on the abdomen
and the nates separated; seize the tumor between the thumb and finger
and slit it open from within outward in the direction of the radiating folds
of the anus with a sharp-pointed curved bistoury; turn out the clot, cleanse
the wound, and pack it gently with iodoform gauze, to exclude infection
and prevent premature union. Under the influence of a daily dressing and
quiet, a rapid and safe cure ensues.

The Excision Methods.—Excision alone is employed in the removal of
quiescent hæmorrhoids, and, combined with ligature, is practiced in the
removal of both limited and extended hæmorrhoidal growths. The integu-
mentary tabs—the sequel of external piles—can be cut off directly, on a
line with the surface to which they are attached, with scissors. The little
hæmorrhage that follows is easily controlled and healing facilitated by clos-
ing the cut surface with a suture or two of fine catgut. Not infrequently,
however, in this class of cases the hæmorrhoids become distended again with
blood, very œdematous, exceedingly painful, and in rare instances gangre-

nous. They are then readily removed by ligature and excision, or clamp and cautery.

Allingham's Method (*Longitudinal Excision and Ligature*).—Give an anæsthetic, place the patient on the back with the buttocks near the edge of the table, thighs flexed and separated with the Clover's crutch and nates drawn apart. Dilate the sphincter completely; expose the lower three inches of the bowel with a speculum; seize the lower end of each hæmorrhoid in turn with forceps, draw it downward, and with a pair of strong scissors separate it from the underlying tissues in the long axis of the bowel by cutting and dissecting from the muco-cutaneous junction upward to the apex of the pile, at which point it is tied with a strong silk or catgut ligature and removed.

The Remarks.—The point grasped by the ligature is an "isthmus of vessels and mucous membrane." The normal direction of the vessels renders the separation easy and comparatively bloodless unless the vessels be divided. Loose perianal skin is snipped off, care being taken not to remove too much, and the cuts closed in with fine catgut sutures. On numerous occasions the writer has closed with fine catgut the furrows in the mucous membrane resulting from the removal of the hæmorrhoids. Internal piles having a distinctly columnar outline are the ones best fitted for this method of treatment.

Whitehead's Method (*Circular Excision and Ligature*).—Whitehead's method of operation consists in excision of the pile-bearing tract. Place the patient in the lithotomy position, using Clover's crutch (Fig. 1598); dilate the sphincters fully; divide carefully the mucous membrane around the anal opening at its junction with the integument; with forceps and scissors expose the inner border of the external and the beginning of the internal sphincter; separate the attached membrane and the associated hæmorrhoids from these muscles and the subcutaneous tissue by rapid blunt dissection, and occasional division of restraining bands, and draw it downward below the anus; sever the mucous membrane above the hæmorrhoids in successive parts, and sew them at once to the corresponding portions of the anal margin of the integument with silk; dust the parts with iodoform and place the patient in bed.

The Precautions.—Care should be taken to divide the mucous membrane *at its junction* with the integument, as failure in this respect is often followed by annoying sequels. The flaps should be cut with great care, and only the excess of tissue beyond that requisite to easily cover the raw surface without tension removed, as retraction of the mucous cuff would leave an annular surface to heal by granulation with resulting subsequent stricture of the anal opening.

The Comments.—The sphincteric borders should be carefully determined, and the deeper tissues cautiously separated to prevent hæmorrhage. The separation should extend above the affected area—an inch or two—so as to facilitate downward displacement and ready union of the healthy border of the mucous membrane with the integumentary margin without danger of undue subsequent traction. The bleeding of the operation is attendant mainly on division of the mucous membrane, and although

70

[illegible] dangerous; it is best controlled [illegible]. The introduction into the anus [illegible] gauze (Fig. [illegible]) wrapped around a catheter [illegible] purpose of causing coaptation of the tissues, and at the same time permitting the escape of gas, is sometimes practised [illegible] the operation. However, the presence of this [illegible] disagreeable to the patient, and often causes [illegible] and the sphincteric contraction [illegible]. The division and sewing of the mucous stump [illegible] maintain complete control of the bowel, and [illegible] tension at the line of union. The [illegible] mucous membrane endowed with special sensibility [illegible] regarded as objectionable [illegible] with equal promptness, less suffering and danger of annoying complications and sequels by simpler methods. [illegible] of the veins without special [illegible] method.

[illegible] method good [illegible] is ulcer, stricture, [illegible] and faeces are re- [illegible] Andrews* regards is probably due [illegible].

Ligature.—[illegible] because points of actual and anticipated bleeding [illegible] by ligature and tissues strangulated by ligature should be removed by cutting, for obvious reasons. In connection with ligature of hæmorrhoids, it now remains to speak of treatment by submuco-cutaneous and transfixion ligature of these tumors, followed by excision.

Fig. [illegible] Submuco-cutaneous ligature and excision.

Pass submuco-cutaneously a chromicized-catgut suture, seize with a

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* Mathew's Medical Quarterly, 1895, p. 303.

hook, lift up and sever the hæmorrhoid, tightening the ligature at the time. Finally, tie securely, thus converting the hæmorrhoidal site into a simple incised wound with securely apposed borders (Fig. 1396).

An Old Method.—Seize the pile with forceps, incise the skin close to the base if the pile be of the intero-external variety, transfix the tumor with a needle bearing a double ligature; interlock the ligatures, tie the tissues firmly in halves, and cut off the strangulated growths. This is a rapid and safe method when conducted with due aseptic regard. The loss of blood is slight, and for these reasons the practice is indicated in feeble and aged patients affected with large and well-formed piles.

The Remarks.—In this method, as in others of like nature, the too free removal of mucous membrane is likely to be followed by narrowing of the anal orifice. The sequel can be prevented by leaving between the respective ligatures independent areas of mucous membrane. The contraction attending the cure of the large will remedy the small, untied hæmorrhoids. If too large for spontaneous cure, they may be punctured with the heated point of a Paquelin cautery without causing objectionable contraction of the mucous membrane. Instead of transfixing the pile, it can be surrounded and strangulated by a single heavy ligature, preferably silk.

Coates's Method.—Seize the pile with forceps and draw it down, and apply to the pedicle a long, narrow clamp; pass beneath the clamp a proper number of sutures of fine catgut; excise the pile, loosen the clamp, check bleeding, remove the clamp and tie the sutures tightly.

Mitchell's Method.—Clamp the pile in a long narrow-bladed forceps (Fig. 1397), cut away the clamped-off portion with scissors, insert a catgut suture, hardened in formalin, immediately above the clamp with a curved needle, and tie the free end (Fig. 1398); with the threaded end make a continuous suture, passing around the clamp and through the stump (Fig. 1399); withdraw the clamp and tighten the suture, avoiding puckering of the line of union (Fig. 1400).

The Remarks.—The portion of the suture which is tied first above the clamp must be passed deeply down to the internal sphincter, so as to include in its grasp the main vessels, or hæmorrhage will not be controlled. The advantages of this method are its rapidity; there is no loss of blood; the suture is an efficient hæmostatic, and there is no danger of subsequent hæmorrhage; no raw surface is left, and, as a rule, patients are up at the end of a week.

The Clamp and Cautery Method (Cusack).—The method by clamp and cautery is strongly advised by many eminent surgeons, and surely the promptness and efficiency of the practice can be highly commended.

The Operation.—With the patient under an anæsthetic, in the lithotomy position and with the sphincter dilated, seize the tumor with the forceps, and draw it from the anus or expose it with a speculum; divide the cutaneous surface, if present, with blunt-pointed scissors or a knife; apply the clamp (Fig. 1374, *q*) to the base of the tumor in the long axis of the gut, including the cutaneous sulcus if present, and screw the blades firmly together; cut away the tumor with scissors and cauterize the stump deliberately with red heat (Paquelin cautery); loosen the clamp, and, if bleed-

ing occur, close it and cauterize again. The tumors are thus treated one by one until all are removed.

The Remarks.—Tuttle has pointed out in this operation the importance of leaving an interval of uninjured tissue, about an eighth of an inch

FIG. 1397.—Clamping the pile, Mitchell's method.

FIG. 1398.—Pile cut away. Sewing begun, Mitchell's method.
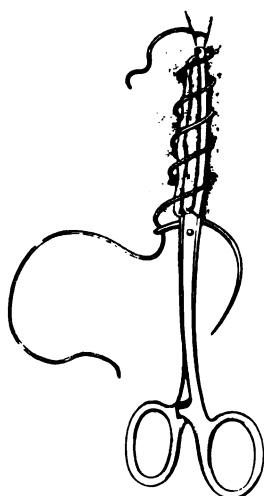
FIG. 1399.—The sewing completed, Mitchell's method.

FIG. 1400.—The operation completed, Mitchell's method.

in width, between the site of crushing and that of cauterization. By this means the crushing and the cauterization together furnish a twofold hæm-

ostatic action on the divided tissues. Should the stump, on the other hand, be burned even with the clamp and down between its blades, the line of crushing would be destroyed and hæmorrhage would likely result. Tuttle applies the clamp with the heel of the instrument at the upper portion of the tumor where the large vessels of entrance and exit are situated, since at the heel the blades close first, and therefore the greatest amount of pressure can be exerted there. The choice of a hæmorrhoidal clamp is important. The proper instrument should be one in which the tongue of one blade does not completely fill the groove of the other, and in which the edges of the tongue and groove are not too sharp. The reverse of either of these conditions tends to cut the pile with resulting hæmorrhage, rather than to crush it. The original model of Kelsey's clamp fills these conditions. The tissues should be slowly and thoroughly charred, otherwise hæmorrhage will take place. If the growths be large the clamp should not grasp the tissue quite down to the anal junction for fear of causing subsequent contraction. However, in cases with relaxed sphincter this precaution is not of so much importance. Care should be exercised not to burn the integument, as such injuries are very troublesome.

The Results.—This operation is quickly performed and the results are very satisfactory. Caution is needed to note the entire absence of bleeding before the patient is removed to bed, as much blood may accumulate in the bowel without the least escape from the anus.

Injection.—The injection of carbolic acid and of astringent agents, together with the application of caustics, are not entitled to the dignity of rank sometimes accorded to them. The occasional severe inflammatory reaction, often followed by abscesses and gangrene, and the fickleness of cure unfit these measures for trustworthy station with the methods of cure.

The General Remarks.—Internal hæmorrhoids associated with cirrhosis of the liver should not be removed, since they then furnish a channel of collateral circulation for the portal blood. If they are removed under these circumstances, ascites is liable to result. In instances of excision or ligature of hæmorrhoids having a cutaneous surface, the cutaneous surface should be divided in the line of the proposed constriction with a knife or blunt-pointed scissors—the latter being the better—before tying is attempted. If this be not done, the degree of pain incident to tying in of the skin will be severe and quite persistent.

In those cases characterized by a rosette arrangement of the hæmorrhoids completely around the bowel within the anus, the circular mass should be divided into five or six segments and separately ligatured. The segmentation can be executed by means of a grooved director through a small incision in the mucous membrane made at either side of the pile, or by direct incision, or transfixion with a needle armed with a ligature. When properly isolated the segments are tied separately with silk or chromicized catgut.

The transfixion and tying of hæmorrhoidal growths is regarded by many as improper practice. It is claimed that a needless amount of tissue is included, that vessels are punctured and infection invited by the practice. The writer is not disposed to regard the measure as objectionable in iso-

lated tumors with thorough asepsis, and has practiced it not infrequently, and thus far without an unfavorable result.

General anæsthesia meets the requirements more completely than local; the latter, however, is sufficient in the simplest cases. Catgut ligatures are liable to slip and be followed by hæmorrhage; silk ones are safer, but more likely to be annoying because non-absorbable. Narrowing of the anus rarely follows in ligature or cautery except the integument be encroached upon. Dependent incisions should be made first, to avoid obscurement of the line of incision by blood. The strength of ligatures should be tested before applying them to the hæmorrhoids. Temporary retention of urine is a frequent sequel of operation for hæmorrhoids, and the occurrence should be anticipated and provided for in each instance.

Fig. 1401.*—Anatomy of lower rectal region. Ramus and tuberosity of ischium cut away and sphincter detached anteriorly. *An.* Anus. *Sa.* Tip of Sacrum. *M.* Anterior fibers of levator ani. *N* and *O.* Levator ani, reflected. *P.* Recto-vesical fascia cut open and reflected from antero-lateral portion of rectum, showing middle hæmorrhoidal artery *S*, its branch to the prostate *T*, and the prerectal space *U* opened up. *U* is placed on base of prostate, at which situation the artery enters. *Q.* Recto-vesical fascia postero-laterally. *W.* Fascia covering vesiculis seminalis.

The choice of operation is largely a matter of personal experience. The author employs excision and ligature after the manner of Allingham, and ligature alone by transfixion more frequently than he does the other methods, and thus far without regret. The excision of the pile-bearing tract is a logical procedure and in extensive involvement at the anus is widely practiced. Mr. Whitehead, the designer, and others have performed it on numerous occasions with excellent primary and final success. The clamp-and-cautery plan is a good one, especially in well-defined growths, and is ably advocated by Kelsey of this city.

The after-treatment is simple and consists of the application to the anus of iodoform; a cotton pad held in place with a T-bandage; opium for pain and spasm. The patient should be kept quiet in bed for four or five days and cleanliness of the parts secured. About this time obtain a good movement with oil supplemented with a simple enema. The preliminary diet should be devoid of solid food.

* Medical and Surgical Report of Bellevue Hospital, i, 1904.

The Results.—The death rate in St. Mark's Hospital "from all causes in operations on internal hæmorrhoids by ligature during a space of more than forty years is just 1 in 670" (Allingham). *Allingham* reports over 1,600 cases of his own with but a single death. Other surgeons of exten-
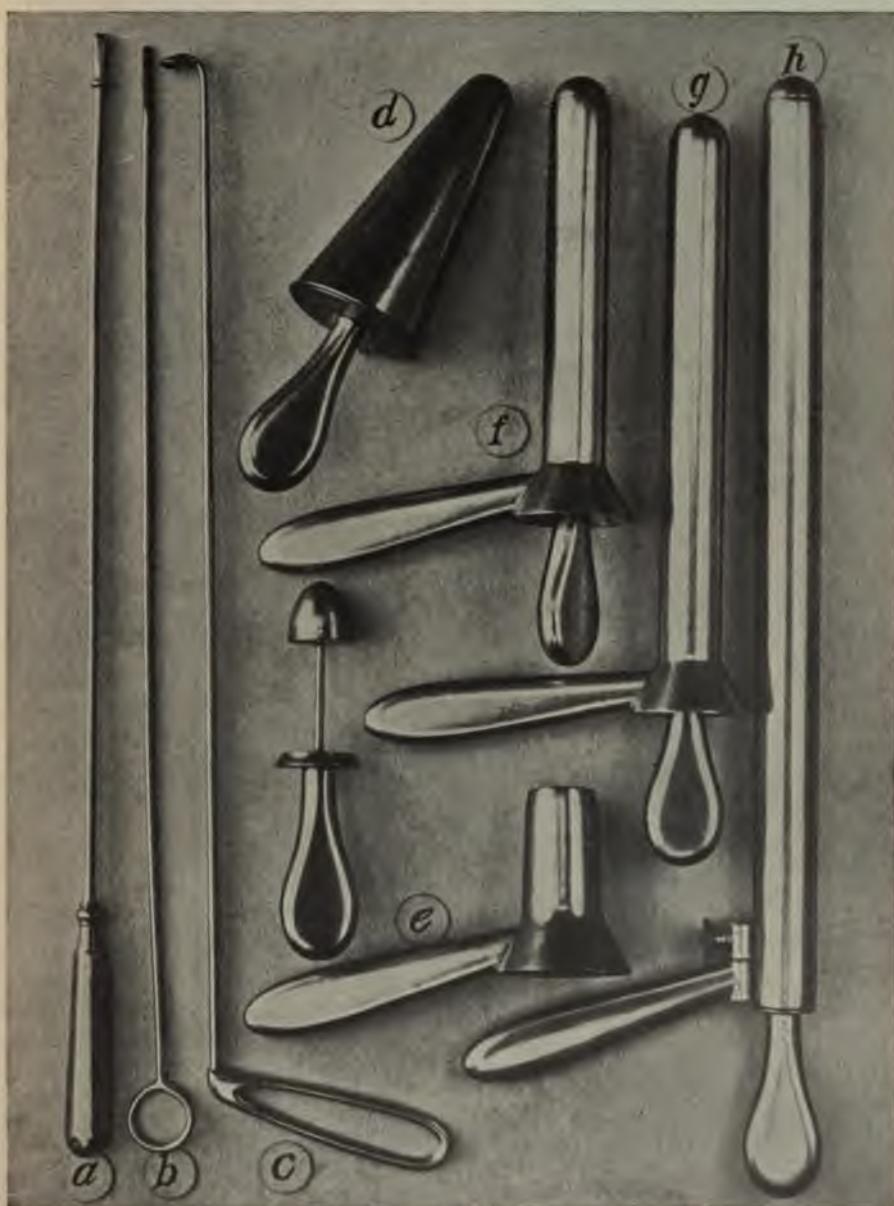
FIG. 1402.—Instruments employed in examination of the lower bowel.

a. Sponge holder. *b.* Applicator. *c.* Curette. *d.* Anal dilator. *e, f, g.* Proctoscopes, assorted lengths. *h.* Sigmoidoscope. Various forms of rectal specula (page 953) may be employed in examination of the lower part of the rectum.

sive experience make similar favorable reports. Where properly performed the affection seldom returns and then only after many years.

Operations on the Rectum.—The protected position of the rectum exempts it from many of the common injuries to which the abdominal contents are exposed. However, disease of this bowel is sufficiently frequent to demand its careful consideration.

The Anatomical Points.—The rectum extends from the upper portion of the anal canal to the level of the middle of the third sacral vertebra, which is the situation where the large intestine ceases to have a meso-attachment. This upper limit was first proposed by Treves and is now the one generally accepted. *Quénu* and *Hartmann* give the length of the rectum as from eleven to fourteen centimeters (4.3 to 5.5 inches), and divide it into an ampulla below, nine to eleven centimeters (3.5 to 4.3 inches) in height, and a cylindrical portion above, two to three centimeters (.8 to 1.2 inches) in height. These authors have made a number of casts of the rectum and anal canal, one of which is shown in Fig. 1367, which presents typical features. The cast shows the direction of the anal canal and rectum which should be followed in the introduction of instruments. The groove in the front of the cast represents the anterior valve of Houston, at
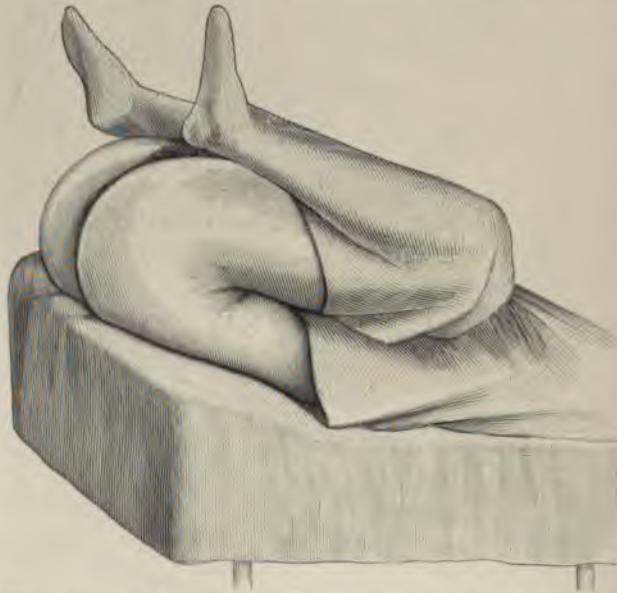
Fig. 1403.—The exaggerated lithotomy position for examination of the anus and rectum.

which level the peritonæum is reflected on to the bladder. According to *Quénu* and *Hartmann*, in the male, the distance from the peritoneal *cul-de-sac* to the anus is from five to six centimeters (2 to 2.4 inches) with the bladder empty, from seven to eight centimeters (2.7 to 3.1 inches) with the bladder full, and it may reach ten centimeters (3.9 inches) if the rectum is likewise distended. *Tuttle* states that in the female the distance

from the peritoneal *cul-de-sac* to the anus is from one to two centimeters (.4 to .8 of an inch) less than in the male. The rectum fills out the lower portion of the pelvic cavity between the base of the bladder in front, and the sacrum and coccyx behind. Below the peritoneal covering, its walls reach laterally out to the spines of the ischium, and are then reflected over the recto-vesical fascia which surrounds and supports it below. It is in relation anteriorly in the male with the trigone of the bladder, prostate, seminal vesicles, vasa deferentia, and the basal layer of the triangular ligament beneath the membranous urethra (Fig. 1401), and in the female with the posterior wall of the vagina. It is in relation postero-laterally on either side with the sacral plexus and the pyriformis muscle, which structures are separated from it by pelvic fascia. The longitudinal coat of the rectum is attached posteriorly in the median line below the middle of the third sacral vertebra by a fibrous septum to the sheath surrounding the rectum. The rectum receives its nerve supply chiefly from the sympathetic system, and consequently has little sensibility.

Fig. 1404.—Tuttle's pneumatic proctoscope.

Rectal Examination.—Two methods of direct rectal examination are practiced: 1, by the fingers, specula (Figs. 1404 and 1406), light, etc., aided by the position of the patient; 2, by the introduction of the entire hand.

In the former method, cleanse the bowel thoroughly and empty the bladder; place the patient in the latero-prone or the exaggerated lithotomy or knee-chest position, depending on the scope of the examination. If only digital examination be intended the first will suffice. Oil the index finger and introduce it gently with a semirotary motion, allowing the remaining fingers to remain between the nates. By this method the lower four or five inches of the gut can be palpated with the use of moderate force. The extent of the examination is increased somewhat if the patient bear down. The introduction of the middle finger along with the index adds still more to the extent of the examination. An educated touch will enable the surgeon to comprehend with astonishing exactness the physical state of the rectum and its surrounding structures. The use of a speculum, aided by a good light, will permit observation of the lower half of the gut. However, to secure a more thorough and extended inspection, place the patient in the

exaggerated lithotomy position (Fig. 1403); then draw backward the posterior wall of the rectum with a Sim's speculum; press the anterior wall forward with a uterine or a special depressor, or the handle of a tablespoon, when, with the aid of a good light—electric or otherwise (Fig. 1405)—the lower four or five inches of the rectum can be quite well seen. The use of a small, soft sponge on a sponge holder will aid much by smoothing out the folds of the bowel and wiping its surface clean. Under the influence of a strong light and the bowel well distended with air, three valves, and sometimes four, are observed. The largest and most constant is usually connected with the anterior wall at a point opposite the peritoneal reflection on to the bladder. The second largest is attached to the right wall of the

Fig. 1405.—High examination of the bowel, patient in knee-chest position.

bowel, two centimeters above the first. The third, two centimeters below the first, at the left wall of the gut. When present, the fourth arises toward the left from the posterior wall and is about an inch above the anus. The fact that they may be mistaken for evidence of disease and often do become the seat of diseased action prompts the giving of this somewhat detailed description. The bowel can be examined yet higher by placing the patient in the knee-chest position (Fig. 1405) and employing the long proctoscope (Fig. 1402, g) or the sigmoidoscope (h), supplemented by a strong light and a head mirror. The most satisfactory proctoscope is the pneumatic one fitted with an electric lamp. Tuttle's proctoscope
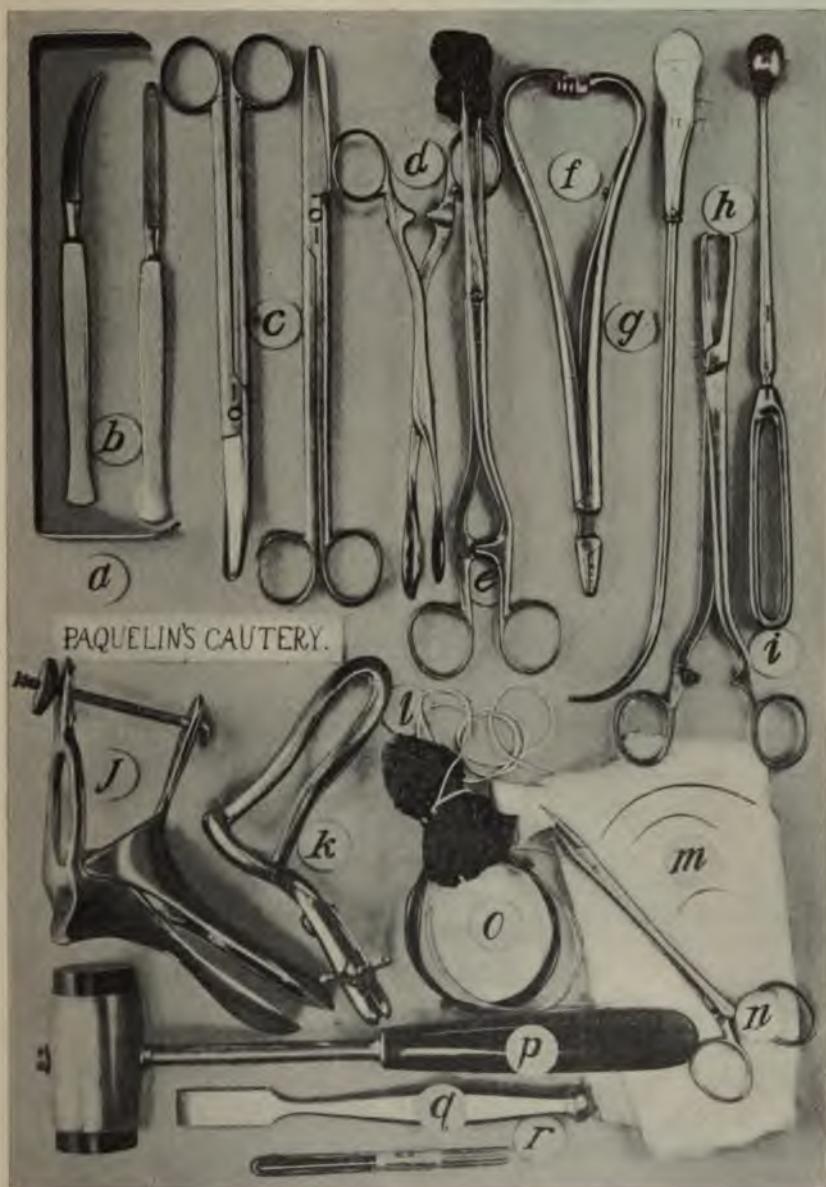
FIG. 1406.—Instruments employed in operations on the rectum.

a. Blunt flat retractor. *b.* Curved and straight blunt-pointed bistouries. *c.* Long straight and curved scissors. *d.* Tongue forceps for grasping rectum. *e.* Sponge holder. *f.* Needle holder. *g.* Steel sound. *h.* Forceps for grasping bowel. *i.* Scoop. *j.* Duckbill speculum. *k.* Fenestrated speculum. *l.* Sponge with string attachment for closing bowel above. *m.* Long and short needles. *n.* Aseptic pad anchored. *o.* Chromicized catgut and silkworm gut. *p.* Mallet. *q.* Chisel. *r.* Black silk. Scalpels, ligatures, wipers, forcipressure, and blunt dissector are required.

(Fig. 1404) combines these features. The tube is introduced through the anal canal by means of an obturator, then the latter is withdrawn, and the external orifice of the tube is made airtight by means of a metal cylinder with a piece of plain glass fitted into its bore. An air bulb connected by means of a tube with the interior of the instrument inflates the bowel. As the bowel fills with air the proctoscope can be advanced without injuring it. In air distention of the rectum for proctoscopic examination the position of the patient should be one that takes the visceral pressure off of the rectum, as the knee-chest position, or the latero-prone position with the hips raised. In either of these positions the lumbar spine must be arched well forward, or a view of the lower portion of the posterior wall of the rectum can not be obtained.

2. *The Introduction of the Entire Hand.*—The introduction of the entire hand must be done with great caution in order not to lacerate the bowel or the peritonæum enveloping it. For this purpose the patient is placed upon the back, anæsthetized, bladder emptied, and the services of a person with a small hand, *not exceeding eight inches in circumference*, are enlisted. The hand is well oiled, and given a conical form by applying the thumb to the palmar surface of the approximated fingers. The tips of the fingers are then carefully inserted by a semirotary motion, which is slowly continued until the whole hand enters the bowel. After the entrance of the hand, the fingers are moved in various directions to ascertain the caliber and condition of the gut, and, at the same time, to favor the circulation of the imprisoned hand.

If the hand meet a narrowing of the bowel at a distance of three or four inches above the anus, but little force should be used, as the peritonæum, which is connected with the gut in this situation and is the probable cause of the narrowing, may be ruptured. If the hand be unusually small, it not infrequently happens that the sigmoid flexure may be passed, the descending colon entered, and the kidneys, uterus, and great vessels, etc., be intelligently examined. It is, however, extremely fatiguing to the examiner; still, the discomfort experienced should not lead the surgeon to relax in the least the degree of caution necessary to the safety of the patient.

Ischio-rectal Abscess.—Abscess of the ischio-rectal fossa is of comparatively common occurrence. Its chief surgical importance relates to fistula in ano. The abscess may be caused by perforation from within the bowel, and therefore when incised from without leads to prompt development of a complete fistula in ano. On the other hand, if the abscess have no internal communication at the outset, one may soon develop from localized sloughing of the intestinal wall from suppuration.

The Anatomical Points.—The ischio-rectal fossa is located between the end of the rectum and the tuber ischium at each side (Fig. 1407). It is triangular in shape, the base corresponding to the perinæum, and the apex to the point of origin of the anal (*g*) from the obturator fascia (*f*). The ischio-rectal fossa is about an inch in width at the base and two inches in depth, being deeper behind than in front. It is limited in front by the junction of the deep and superficial perineal fasciæ, behind by the gluteus

maximus muscle and the great sacro-sciatic ligament. It is filled with adipose tissue, through which run hæmorrhoidal vessels and nerves and branches of the internal pudic, sometimes of large size. Also a branch of the fourth sacral nerve is found at the back part of the fossa, and the superficial perineal vessels and nerves at the front. This fossa is divided up into a number of fascial compartments, so that abscesses here are generally multiple, and when opened, all the pockets must be broken down with the finger. Pus in one ischio-rectal fossa can pass to the ischio-rectal fossa of the opposite side through the fibro-cellular interval between the posterior portion of the external sphincter and the levator ani.

The Operation.—Thoroughly cleanse and shave the perinæum; employ local or general anæsthesia as circumstances demand. The situation, direc-
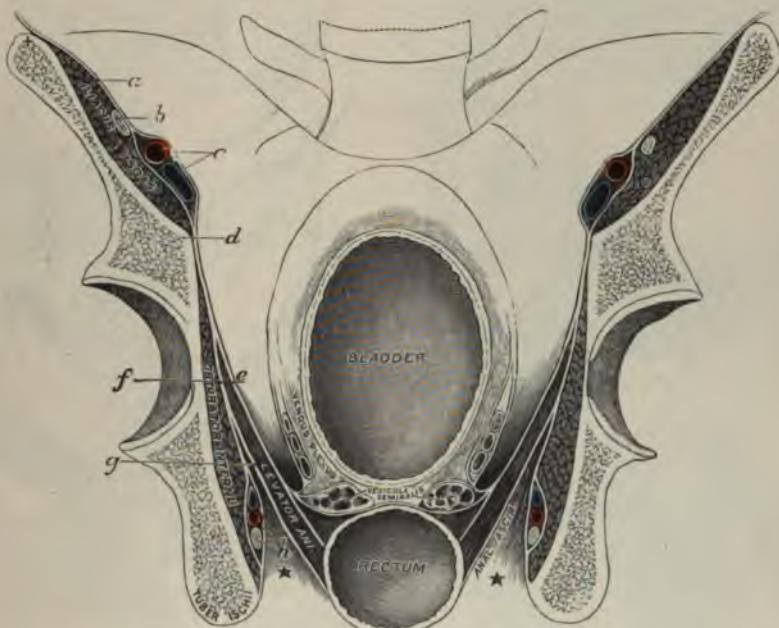
FIG. 1407.—The ischio-rectal spaces and contiguous anatomy. *a.* Iliac fascia. *b.* Anterior crural nerve. *c.* Iliac vessels. *d.* Brim of pelvis. *e.* Recto-vesical fascia. *f.* Obturator fascia. *g.* Anal fascia. *h.* Internal pudic vessels and nerve. ★ Ischio-rectal fossæ.

tion, and extent of the liberating incisions will depend on the location and extent of the abscess. If the abscess be superficial, either antero-posterior or radiating incisions are suitable. If deep, the radiating should be employed, carefully avoiding the sphincter ani and the internal pudic vessels. Circumscribing incisions should be avoided. If abscess be in front of the rectum a transverse perineal incision in the male and vaginal incision in the female may be required. If behind, or at the side of the bowel high up, a posterior median incision may be needed. In all instances the finger should be carried into the opening and search made for channels and pock-

79*

ets, exploring freely in every direction. A single cavity may be formed if practicable; if not, the side pockets should be drained by suitably located incisions. Thorough cleansing and light packing with gauze should follow. Packing of the abscess cavity should be used only for the control of primary hæmorrhage. Continuously used it only keeps the wound open. The cavity should be freely opened for drainage, its walls allowed to collapse, and as bridges of tissue form in healing they should be broken down with a probe.

The Remarks.—Abscess may develop between the recto-vesical and anal fascia, and at either side between the levator ani muscle and the base of the bladder, or it may extend from the ischio-rectal fossa to these situations. An ischio-rectal abscess may be of limited size, located at any part of the fossa or invade the entire space. The devious curves pursued by the sup-puration, and the greater need of care to secure good drainage call for the exercise of patience in the detection and drainage of the suppurating

Fig. 1408.—Imperforate rectum, with rudimentary anus.
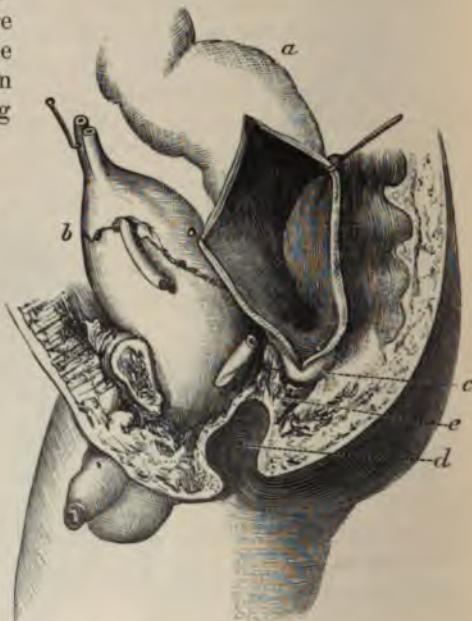
Fig. 1409.—Imperforate rectum, anatomical relations. *a.* Upper rectum. *b.* Bladder. *c.* End of pouch. *e.* Septum. *d.* Lower rectum.

recesses. The sooner and freer the openings are made the less will be the extent of the invasion and the prompter the recovery.

Imperforate Rectum (Figs. 1408 and 1409).—The occluding tissue in imperforate rectum varies in thickness, and is usually situated within half an inch of a normal anus. If the septum be thin, it will be influenced by the emotions of the child and depressed by the superimposed fæcal accumulations; also evidences of fluctuation may be present. At all events, the use of an aspirating needle will aid much in settling the question of thickness. Intraperitoneal exploration by either the sacral or perineal route for diagnosis is commendable practice. The presence of an anal depression is

not evidence of a thin septum; on the contrary, the reverse may be noted. The presence of a normal anus may mislead one as to the true nature of the

FIG. 1410.—Absence of anus and lower part of rectum, rectum opening into bladder.

FIG. 1411.—Absence of anus and lower part of rectum, rectum opening into urethra.

case, therefore a careful and extended examination should always be practiced. In some instances the rectal pouch is high in the pelvis or abdomen, when the interval between it and the perinæum is a distinct fibrous cord
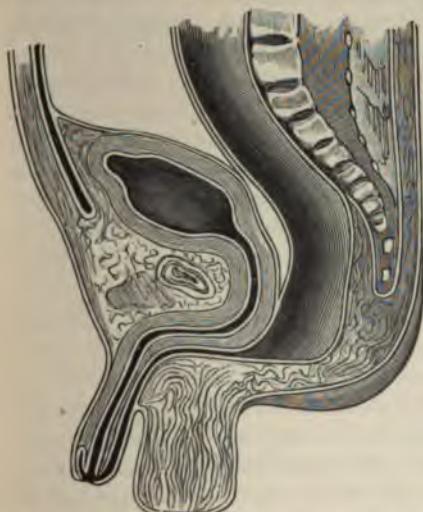
FIG. 1412.—Absence of anus, lower part of rectum communicating with glans penis.

FIG. 1413.—Absence of anus, rectum opening into vagina.

(Fig. 1370). Not infrequently the rectum communicates with the bladder (Fig. 1410), sometimes with the urethra (Fig. 1411), and even the glans

penis (Fig. 1412), conditions which are determined by the character of the urine. Female children suffer from congenital abnormal outlets of the rectum and anal communications (Figs. 1413 and 1414). Prompt diagnosis and prompt treatment are essential to success in these cases in all instances of complete occlusion. In incomplete occlusion, with dribbling of intestinal contents, nothing can be gained by delay, except perhaps in those cases with a vesical or urethral opening. It should be recalled that the operations are addressed in every instance to infantile dimensions. The diameters between the important bony prominences which serve as guides are scarcely more than an inch in any instance. *The primary indication* of treatment is to establish an artificial anus, preferably in the inguinal region.

The Operation.—With the patient in the exaggerated lithotomy position (Fig. 1403), introduce the finger into the rectum, note the seat and extent of the septum, and make incisions into it, radiating from the center; evacuate the contents of the gut, trim off the flaps, and maintain the opening by the occasional introduction of a well-oiled bougie. Sometimes the occlusion is so thick as to raise the question of the presence or absence of the gut above. The sigmoid flexure may terminate in a blind point, while the rectum below is marked by an impervious cord (Fig. 1370). An attempt should always be made to find the blind extremity, which is practiced by introducing a sound into the bladder and carefully seeking, by aid of the scissors and finger, for the *cul-de-sac* above. In the search the established relation which the rectum bears to the curve of the sacrum must be carefully re-

Fig. 1414.—Imperforate rectum, lower portion of rectum communicating with vagina.

garded, and the fibrous trace of the rectum sought after and followed. If the abdomen of the patient be pressed upon, an existing tumor above will be made more distinct and tense. If the *cul-de-sac* be found, the diagnosis should be still further strengthened by exploring the tumor with a hypodermatic syringe or a small aspirating needle carried into its posterior aspect. The release of the fæcal accumulation is often attained quite readily by this method. However, the primary success often is quite misleading, since the time, trouble, and pain necessarily attendant on the persistent employment of bougies to maintain patency of the opening becomes so much of an infliction, as soon to be unbearable, and death ensues in a large number of cases. This plan can not be commended. If possible, the blind extremity of the gut is drawn carefully downward toward the external opening, and held in this position by forceps or by a loop of thread passed through its apex while it is opened carefully, the incision being

guided by the exploring needle, which is allowed to remain for that purpose. After the contents are evacuated and the parts thoroughly cleansed, a sponge with a string (Fig. 1406, *l*) attached to it is pushed up into the bowel to prevent any further escape of fæcal matter, while the extremity of the bowel is sewed to the surface below (proctoplasty).

Proctoplasty.—Proctoplasty consists in drawing down the rectal pouch, and uniting its borders to the normally located anus, or, in the event of the presence of a rectal pouch too short to be thus treated, the establishment of a new anus at the tip of the coccyx, or, as in sacral proctectomy, still higher up in this region, if need be, after removal of the coccyx or lower portion of the sacrum (page 1225). When this step is impracticable, or the extremity of the bowel can not be found, colostomy (page 823) should be performed. As the rectum sometimes communicates with the bladder, and even the glans penis or vagina, various plans of operation are practiced.

Rizzoli's method (recto-vaginal) of treatment of this class of cases is practiced as follows: Place the patient in the exaggerated (Fig. 1403) lithotomy position; introduce into the rectum through the abnormal vaginal orifice a sharply curved vesical sound (Fig. 1413); make an incision in the median line from the margin of the abnormal anal orifice in the vagina down to the rectum and to the tip of the coccyx; expose the rectum cautiously as far as possible by the median incision; dissect out the vaginal anus; separate the attached intermediate portions of the rectum, and transplant the vaginal anus and its connections to the posterior angle of the wound, as near to the coccyx as possible, without much traction; stitch the margin of the transplanted anus to the posterior angle of the wound; unite the borders of the vaginal wound with each other, and, lastly, also those of the perinæum. Dress the wound in the usual manner and maintain cleanliness. In the other forms of this variety of infliction the bowel should be sought for, drawn down, and the abnormal communication located and closed by sutures, if possible, and the end of the bowel stitched to the cutaneous border of the wound. This plan of action is especially serviceable in the involvement of the penis, particularly if supplemented with slitting up of the sinus. In the vesical variety, however, the outcome is dubious because of the higher situation and larger size of the opening, and the greater difficulty of securing suitable adjustment of the rectal wall. In the latter cases the bladder should be evacuated frequently to prevent distention during the healing process. Colostomy may be the only measure of substantial relief in bad vesical cases.

The Precautions.—The narrowness of the compass of the field of operation should be kept constantly in view to avoid the ill effects of a too vigorous or extended dissection. The use of trocars in search of the blind pouch is uncertain and often hazardous, since there is no definite assurance as to its size, situation, and relation to contiguous peritoneal surfaces; careful dissection with scissors, etc., is the safer and equally serviceable. The establishment of a fistulous opening at any point whatever, in the presence of the ability to create a rectum with a proper anus (proctoplasty), should not be entertained except as a brief ameliorative measure.

The Results.—The final results are not encouraging except in simple

cases, such as those with thin septa and good reparative processes. The outcome in the various operative measures is succinctly stated by *Cripps* in a tabulated statement of a hundred cases:

Colon opened into the groin......	16	cases;	11	died.
Colon opened into the loin........	3	"	2	"
Puncture with trocar.............	17	"	14	"
Coccyx resected..................	8	"	5	"
Perineal dissection or incision.....	39	"	14	"
Complication with vagina.........	14	"	1	"
Miscellaneous....................	3	"	3	"
	100	"	50	"

Twenty-eight per cent of these cases died of peritonitis, 20 per cent directly, and 38 per cent indirectly from failure of relief.

Anders's Series of 100 Cases.

Colon opened into the groin.......	8	cases;	4	died.
Colon opened into the loin........	3	"	2	"
Littre's operation (page 823).....	10	"	5	"
Puncture with trocar.............	4	"	2	"
Incision.........................	27	"	9	"
Proctoplasty (dissection)..........	44	"	13	"
Non-operable....................	3	"	1	"
Miscellaneous....................	1	"	0	"
	100	"	36	"

Prolapsus Recti.—The natural looseness of the submucous connective tissues, coupled with straining during defecation, predispose to prolapse of the rectum. Two varieties of prolapse are commonly recognized, *the partial* and *complete*. In the former only the mucous membrane extrudes, and the prolapse is usually but an inch or two in length, and limited to the anus (Fig. 1115) (prolapsus ani). In the complete variety all the coats of the rectum and its peritoneal covering are involved, attended not infrequently with the descent of loops of intestine, uterine appendages, etc. (Figs. 1416 and 1417). Much discomfort and not a little suffering attends the partial variety; excruciating distress is the characteristic feature of the complete.

The Treatment of Partial Prolapse.—An effort should be made to remove the causes of the prolapse, when, with proper regulation of the diet and bowels, local soothing applications, and rest in bed, with the pelvis elevated for a time, a cure may be effected. At all events, much indeed will be added to the final outcome of operative procedure. The aims in the operative cure of this variety are, 1, *the production of adhesions* of the mucous membrane to the underlying tissues; 2, *the narrowing of the anal orifice* by increasing the sphincteric tone, and otherwise diminishing the anal caliber. The adhesions may be established by clamping and destroying

in the long axis of the bowel isolated portions of the mucous membrane, or by removing similar portions of it by the ligature or the galvano-cautery. If hæmorrhoids be present, they should be ligatured or treated with clamp and cautery, as these measures alone will often effect a cure. The application of Paquelin's cautery, longitudinally or at isolated points, to the prolapsed part, after its return, is an excellent method of procedure, and, when combined with rest in the horizontal position and the production of fluid evacuations, will often effect a speedy and satisfactory cure, especially in the young.

FIG. 1415.—Prolapsus ani.

The Cauterization Method (Van Buren).—Anæsthetize and place the patient in the knee-elbow or knee-breast position (Fig. 1405); reduce the prolapse and expose the parts with Sims's speculum. Then, with the point of a cautery (Fig. 102) at a dull-red heat, make four or five longitudinal stripes about three inches in length at equal intervals apart, terminating externally at the border of the true skin. The number, size, and depth of the eschars will depend on the age of the patient and the severity of the case. In the infant, two or three, a line or two in width, may be sufficient. The older the patient and the severer the case, the deeper should be the eschars.

The Comments.—The eschar should be deepened as the sphincter is approached if the prolapse has been reduced; if not, extreme caution should be exercised on approaching this point, or the peritoneal pouch will be invaded. Portions of mucous membrane having obvious venous dilatations should be carefully avoided. After cauterization dust the eschars with iodoform. During recovery and some time thereafter the patient should be confined to bed and a soft stool obtained, while in the recumbent posture, every two days with a saline laxative. The cautery is often applied before the reduction of the prolapse, in order to more certainly reach the upper limit of the affliction. When this course is pursued, the reduction of the prolapse should follow immediately, to avoid strangulation of the protrusion by the sphincter.

FIG. 1416.—Prolapse of rectum, with invagination.

The possibility of reanimating the sphincter after restoration is somewhat uncertain, depending of course on the degree of paralysis and the

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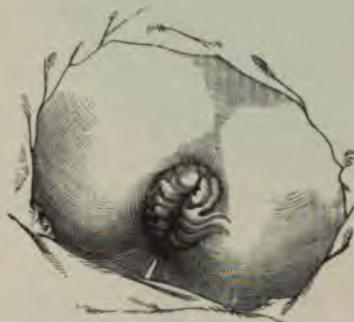
length of time of the infliction. Ofttimes seemingly hopeless cases are markedly improved. The medical expedients directed to the restoration of paralyzed muscles may be employed with some success.

The removal of isolated longitudinal strips of mucous membrane at three or four aspects of the bowel and the union of their divided borders is sometimes practiced instead in cases suitable for cauterization. However, this plan has nothing to commend it and much to disapprove of as a substitute for the cautery.

Cripps advises, after treatment of incomplete prolapse with caustics or cautery, that a thick rubber tube seven inches in length, with a third of an inch lumen, be passed up the rectum for about five inches. Around the mucous surface of the bowel and extending upward as "high as possible" strips of oiled lint are arranged. Finally, between the oiled lint and the tube is carefully packed cotton wool dusted with iodoform. This dressing gives a fine support to the lower part of the bowel and permits the escape of flatus. After forty-eight hours the dressing is removed and the parts are thoroughly cleansed. In a few days the tube only is employed, and this for ten days or more. He advises that the bowels be kept quiet for ten days or so with small doses of opium. He adds, further: "The patient must on no account get up or strain, and the motion is to be passed lying on the side, the anus drawn up a little from the middle line; and this should be enforced for at least six weeks, while consolidation of the eschars is taking place, otherwise the whole advantages of the operation will be lost." Should the presence of the dressing cause a rectal tenesmus not amenable to control by moderate doses of opium, it should be lessened in bulk; failing then, removed entirely.

FIG. 1417.—Complete prolapse of rectum. *a.* Rectum.   *b.* Bladder.   *c.* Uterus. *d.* Pubes.   *e.* Peritonæum.   *f.* Vagina.

The Treatment of Complete Prolapse.—Complete variety of prolapse is met in three forms: 1, In which the external surface of the prolapse is devoid of a sulcus; in this the prolapse follows as the result of the continuous traction exerted by long-standing prolapse of the mucous membrane. Peritonæum is present in the tumor, and sometimes also a loop of intestine (Fig. 1208, *e*). 2, In which a sulcus occurs at the base of the tumor, at the bottom of which the mucous membrane of the gut can be felt as it is reflected from the invaginated protrusion. 3, In which the finger, when 'uced into the anus beside the tumor, fails to detect any evidence of

the reflection of the mucous membrane of the rectum upon the tumor; in this the invagination is extensive, involving perhaps the colon, caput coli, and sometimes the ileum itself.

Each of these varieties should first be reduced; sometimes reduction is accomplished with great difficulty and may be impossible, especially when an acute case is complicated with strangulation of the protruding portion, or a long-standing prolapse, attended with adhesions, is present.

The Reduction of Prolapse.—Place the patient in the knee-elbow or knee-chest (Fig. 1405) position, oil the protrusion, and carefully endeavor to return first the part that escaped last, and, if necessary for the purpose, the external sphincter can be stretched or divided. If this attempt fail, renew the effort by trying to reduce first the part that escaped first. If the manipulation be very painful, the mucous membrane of the protrusion may be painted with a solution of cocain, and even an anæsthetic may be given. To the reduction of the third variety of prolapse must be added the copious injection into the bowel of fluids (page 838) or gases, the introduction of the hand (page 1198), by cœliotomy, and internal restitution and fixation.

Lange's Method (*Proctorrhaphy*).—Place the patient in the knee-chest position; expose the posterior aspect of the rectum by an incision made from the lower part of the sacrum to the anus; remove the coccyx; introduce through only the muscular wall, near the median line, longitudinally a row of catgut sutures so as to fold inward the posterior wall of the bowel; introduce a second row so as to bring the lateral walls still more in apposition, thereby burying the first row; unite the divided borders of the levator ani and external sphincter with sutures; fill the cavity with gauze; close the integumentary wound, leaving room for the introduction of subsequent dressing while the deep parts heal by granulation.

Fig. 1418.—Operation for prolapse of the rectum, Roberts's method. *a.* Anus and triangular incision of the perinæum, with sutures placed. Triangular section of posterior wall of rectum, with sutures placed for tying, seen through window in anterior wall.

The Results.—A severe prolapse six inches in length, of twenty years' standing, that had resisted repeated treatment by cautery and excision of the mucous membrane, was cured by this method.

Roberts's Method (*Elliptical Excision*) (Fig. 1418).—Prepare the patient carefully for the operation; reduce the prolapse while in the lithotomy position; make a small incision in front of the coccyx in the median line of the perinæum; introduce the finger through the incision behind the rectum and break up for three inches its posterior cellular connections; introduce a scalpel through the dilated anus half an inch to right of the median line, and make a deep incision obliquely backward and inward

through the sphincter and skin to the primary incision at the end of the coccyx; repeat the incision upon the left side; remove from the entire thickness of the posterior wall of the rectum a triangular piece about three inches in length and an inch at the base, along with the perineal triangle, with scissors; ligature the bleeding points with catgut; unite the borders of the wound from above downward with chromicized catgut or sterilized silk, placing the first suture at the apex of the rectal wound; introduce successive intrarectal sutures a third of an inch apart, the last one being located just inside the margin of the anus; tie the sutures, leaving the knots within the bowel; bring together and unite the divided ends of the sphincter with a shotted wire and two catgut sutures; introduce a drainage tube between the rectum and sacrum and close the ano-coccygeal wound by shotted wire sutures "carried deeply through the structures by a strong curved perinæum needle." Quietude of the bowel is maintained in the usual manner for a few days, and is followed by an oleaginous or saline laxative.

The Results.—Inasmuch as the healing of the deep parts of the wound by granulation is essential to a cure, the recovery is somewhat protracted and the formation of a fistulous canal need not be unexpected. Operation in ordinary cases has frequently resulted in final relief. The dangers of this operation result from exsection of a portion of the bowel and sphincters. Cutting into the bowel renders great the liability of infection of the wound, and resection of the sphincters takes chances on impairment of the sphincteric control which would result in the event of suppuration of the wound.

Mikulicz's Method (*Amputation*).—Place the patient in the lithotomy position and thoroughly cleanse and disinfect the prolapsed portion; insert the index finger of the left hand into the prolapse and divide the external tube for about an inch parallel to and an inch from the anal margin with a knife (Fig. 1419); pass a stitch so as to unite the tubes together (Figs. 1041, 1043, and 1044), if the space between them be unoccupied by small intestine; tie in a reef knot; leave

Fig. 1419.—Operation of amputation for prolapse of the rectum, Mikulicz's method. Primary sutures applied.

one end short and free and use the other as a continuous quilt suture throughout the circumference of the bowel; sever the external tube as the sewing proceeds, so that cutting and sewing will cease at about the same time; cut through the internal tube and unite the divided edges of the mucous membrane with a continuous suture all round; cleanse the stump carefully and allow it to slip within the anus.

The Remarks.—The opening into the peritoneal cavity that attends this procedure bespeaks the employment of rigid asepsis. Unless care be taken, the stump will slip away as soon as the inner tube is completely divided. But little bleeding attends the operation, since it is controlled by the sewing.

Treves's Method (*Amputation*).—Place the patient in the lithotomy position with the pelvis well raised and draw down the prolapse to the full extent; thoroughly cleanse the field of operation; divide the mucous membrane of the outer wall of the prolapse close to the cutaneous junction, entirely round the base, with a knife; separate and turn down toward the apex of the cone the mucous cuff of the prolapse, by means of scissors and traction; cut across the anterior wall of the prolapse at the base of the cone and shut off the peritoneal cavity with a sponge; rapidly sever the remaining walls of the prolapse with scissors, seizing each inch or so of the cut end of the bowel promptly with forceps, to arrest hæmorrhage and prevent retraction of the mucous membrane; remove the sponge from the peritoneal prolongation and close the opening by uniting the borders of the divided membrane by several fine chromicized catgut sutures; unite the divided end of the bowel to the margin of the anus by silkworm-gut sutures going through the entire thickness of the wall of the gut, and ligaturing the bleeding points as they appear; cleanse and restore the parts to the proper site.

Kleberg's Method (*Amputation*).—Place the patient in the lateral position, with the pelvis raised and the shoulders turned downward on the operating table as far as possible; administer the anæsthetic; cause an assistant to grasp the prolapsus with both hands with the fingers extended downward, and press as hard as possible against the protrusion at a point just below the sphincter; pass upward, beneath the hands of the assistant, around the tumor to its base a strong rubber tube, and draw it only tight enough to arrest the circulation; fasten the tubing securely, and direct the assistant to relax his grasp; make a longitudinal incision anteriorly two inches long through the prolapsed rectum; cut the peritoneal sac at that situation; seize the elastic ligature with forceps, and prevent its displacement downward into the incision; push back into the peritoneal cavity any prolapsed small intestine; thrust a large-sized Leuer's pocket trocar from before backward immediately below the ligature through the prolapse; remove the trocar, leaving the cannula behind; pass two elastic drainage tubes each a line and a half in diameter through the cannula, and remove the latter; tie the ligatures tightly at the respective sides of the prolapse; remove the primary elastic constriction, and cut off the prolapsus an inch below the secondary ligatures with scissors; knead the parts above the ligatures with the fingers for a few moments to displace upward the fluids; protect the parts around the stump with cotton, and soak the stump below the ligature with a mild solution of chloride of zinc; dry the stump, knead the soft parts as before, and apply again the chloride of zinc; cover the whole with dry cotton batting, and cause it to be removed as soon as moist; reapply dry cotton batting, and allow the free access of air to the parts.

The Precautions.—The pressure of the rubber tube prevents the en-

trance through the incision of air or blood during the return of the intestine. Before transfixion with the trocar, be sure that the peritoneal prolongation is empty. If silk ligatures be tied around the knots of the elastic ones, these knots will be much more secure.

The Results.—In a patient to whom this treatment was applied by Kleberg a prolapsus a foot in length and six inches in diameter was removed. At the end of two months the patient had recovered completely. In another case a fatal result followed, due perhaps to the bad state of the patient's health.

Verneuil's Method (*Posterior*).—Put the patient in the lithotomy position and restore in place the prolapse: make outward at right angles with the antero-posterior diameter of the anus from either side of the opening an incision through the integument and external sphincter, about an inch in length; make an incision from the tip of the coccyx at each side so as to meet the terminal points of the preceding ones; dissect and raise from behind forward the triangular flap, including the subcutaneous cellular tissue and the fibers of the external sphincter, leaving them attached at the base to the tissues surrounding the anus; draw the flap strongly upward, and loosen the posterior wall of the rectum for a distance of two to two and a half inches in width, and to a height equal to the distance from the anus to the point of the coccyx. Pass four threads parallel with each other transversely through the posterior wall of the rectum, not including the mucous membrane, placing the upper at a point corresponding with the tip of the coccyx, and the lower, three fifths of an inch from the anus; pass a needle with the eye at the point, from without inward through the skin at places situated an inch and a half from the median line at either side, and withdraw the needle in turn with the corresponding end of each suture. The extremities of the upper suture should escape on a level with the sacro-coccygeal junction, and those of the lower at the tip of the coccyx. Place the remaining sutures equidistant between them; tie together at the respective sides the extremities of the first and second and third and fourth sutures over rolls of gauze, placed beneath the loops to prevent their burial in the tissues; now by strong traction make to enter the rectum in the new position; insert a drainage tube, and sew and unite the triangular flap in its former position. The anus is narrowed by suturing the margins caused by its outward incisions.

. . . . suggested that the beginning of the primary incision should correspond to . . . . amount of dilated anal . . . . . . to form a new anus of suitable size.

Tuttle's Method . . . . This . . . . . method is thus . . . . . by Dr . . . . all prolapse . . . . recto-sigmoidal juncture— . . . the . . . . Fig. 1420). It is based upon . . . . relaxation or giving way of . . . . rectal tissues, and that if . . . . attachments will be . . . . strong enough . . . . hips raised.

Thoroughly disinfect the rectum and external parts. A semicircular incision, about one to two inches long, is then made midway between the anus and coccyx, and extended into the cellular tissue between the rectum and sacrum. With the finger or a long, blunt-pointed, curved scissors the rectum is then separated from the sacrum, as high up as the length of the protruding gut. The sacral surface of the cavity thus made is gently curetted, to remove all fat and freshen the surfaces for future union with the gut. With the aid of an assistant's finger in the rectum, the gut is invaginated (Fig. 1421) through the semicircular incision and drawn down as far as it will come. The external surface of the posterior wall of the gut being thus exposed, is curetted and freshened down to the muscular layer. Long silkworm-gut sutures are now passed transversely through the muscular wall of the gut, taking a bight of about one inch or more each, their ends being left free. From three to five of these sutures are put in, about one half inch apart. Then, with a long Peaslee needle, the ends of the sutures are carried up through the wound (Fig. 1422) and between the rectum and sacrum, and brought out through the ligaments, fasciæ, and skin, one end on one side of the bone and one upon the opposite side. The upper sutures in the gut are brought out, if possible, a little higher than the normal portion of the rectum. When the sutures have been thus passed, they are drawn taut successively from above down-
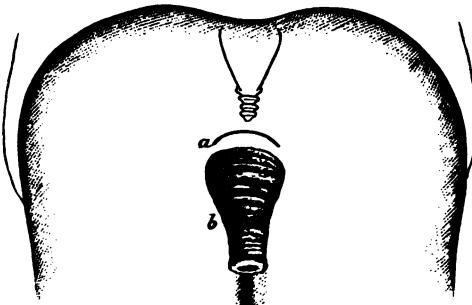
FIG. 1420.—Operation for prolapse of the rectum, Tuttle's method. *a.* Line of incision midway between apex of coccyx and base of prolapse. *b.* Prolapsed rectum.
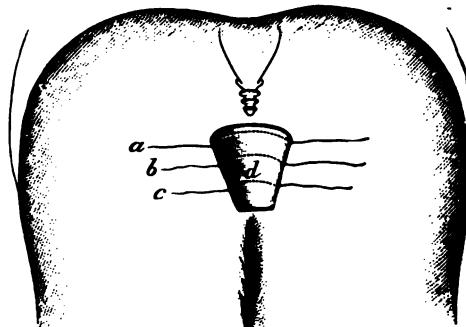
FIG. 1421.—Operation for prolapse of the rectum, Tuttle's method. Gut, *d,* invaginated through incision. *a, b, c.* Sutures passed through muscular wall of gut.
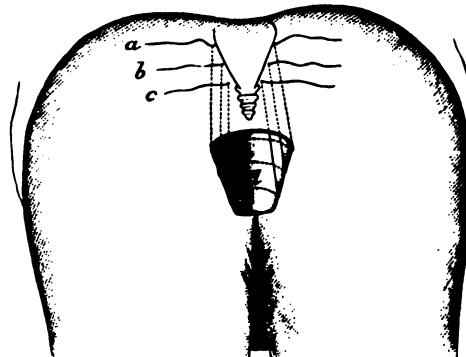
FIG. 1422.—Operation for prolapse of the rectum, Tuttle's method. Sutures passed upward and out at sides of sacrum.

ward, and tied over a fold of iodoform gauze to prevent their cutting into
the skin (Fig. 1423). The rectum is thus held in its normal position by
the sutures, which are left in
from ten days to two weeks.
A buried, circular, kangaroo-
tendon ligature is passed
around the rectum, on a level
with the upper margin of the
external sphincter, and tied
tight enough to constrict the
index finger passed into the
anus. The operation is com-
pleted by closing the semicir-
cular incision posterior to the
anus with chromicized gut su-
tures passed deep enough to
bring together the ends of the
recto-coccygeus and external
sphincter muscles, which will
have been cut. The patient is
kept in bed for three weeks,

Fig. 1423.—Operation for prolapse of the rectum,
Tuttle's method. *a, b, c.* Sutures tied over
sacrum, gauze intervening. *d.* Original wound
closed. *e.* Buried circular ligature for narrow-
ing anus and supporting sphincter. *f.* Outline
of reduced rectum.

and his bowels are moved by enema on the eighth day."

The Results.—Five cases have been operated on by Dr. Tuttle, the first
four 41, 31, 30, and 21 months ago respectively. The fifth case is of too
recent date to merit attention in this
connection. In four cases the average
length of the prolapse and of the time
of infliction was 3.75 inches and 7 years
respectively. Prompt recovery and no
return characterize each case.

Peters's Method (*Proctopexy*).—
Peters carried into effect an operation as
follows (Fig. 1424): Open the abdo-
men in the median line; seize and draw
upward the rectum, restoring the pro-
lapse; narrow the lumen of the lower
portion of the bowel by infolding its
anterior wall and confining the infold in
place by six silk sutures so passed as to
embrace only the serous and muscular
coats (*a* and *c*). The lowest stitch
should be placed as near to the anus as is
possible. If now the rectum be stitched
to the abdominal wall (*b*) as high up as
possible by means of the long ends of
the sutures, permanent restoration may
be expected. A case of two years' stand-
ing without return is reported.

Fig. 1424.—Operation for prolapse of
the rectum, Peters's method. *a* and
c. Infolding the rectum. *b.* Abdom-
inal wall.

Colopexy.—Colopexy consists in the elevation and fixation of the bowel to some part of the abdominal wall for the cure of severe cases of rectal prolapse.

The operation was devised and performed first by Jaennel on February 5, 1889. He opened the abdomen in the iliac region as for the formation of artificial anus, raised the intestine out of the wound, and drew it upward so as to reduce the prolapse of the rectum. He confined the bowel in place by stitching it to the borders of the wound, and by the support of a steel sound, surrounded by gauze, carried through the mesentery, it was retained outside the abdomen. An artificial anus was made on the sixth day following the operation; a movement occurred on the eighth, and the sound was removed on the ninth day.*

The writer operated on a long-standing case of prolapse of the rectum that had resisted other curative measures, on October 31, 1896. At the time of the operation the prolapse was two and a half inches in length and five inches in circumference. It could be readily reduced by the patient, and remained up except with the act of defecation. The sphincter was feeble, the voluntary action being scarcely apparent.

The Operation.—An incision three inches in length, about an inch above and parallel with Poupart's ligament, was made down to and through the
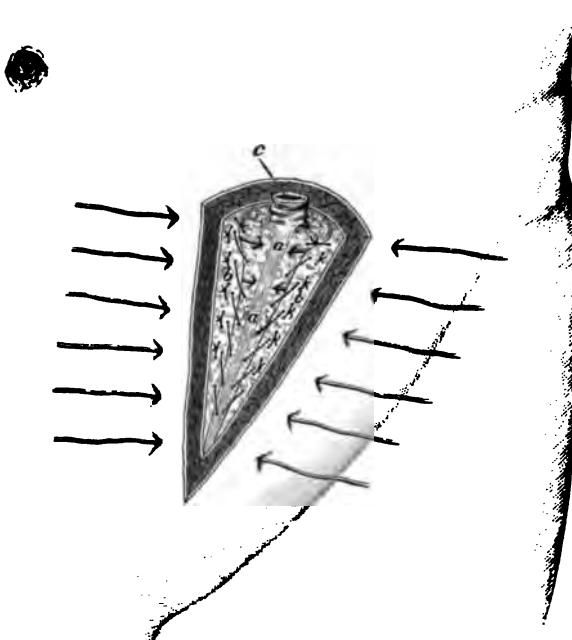
Fig. 1425.—Operation of colopexy for prolapsed rectum, author's method. *a, a.* Muscular band of intestine. *b, b.* Parietal peritonæum quilted and sewed to intestine at either side. *c.* Old fistulous opening.

peritonæum. The peritonæum was separated from the superimposed tissues at either side for an inch at least, but farther above than below. The

* Extract from a paper by the author, published in the Annals of Surgery, August, 1897.

gut was pulled upward firmly, causing the prolapse to disappear entirely; and, while the gut was being thus held, any relaxed tissue of the rectum within reach was drawn down. During firm traction upward on the gut the peritoneal flaps of the wound were joined to it by quilting and continuous sewing with silk, the stitches including the muscular coat of the intestine (Fig. 1425). Six silk sutures were carried through the borders of the abdominal wound so as to include the muscular coat of the gut, behind the longitudinal band. The longitudinal band was drawn forward into the wound almost to the external limit, the sutures were tied firmly, thus causing the border of the wound to grasp the entire band and a small portion of the intestinal wall. The wound healed promptly without an untoward manifestation. The patient was kept in bed for three weeks, after which he was allowed entire freedom of action in all respects. No distinct rectal protrusion appeared after defecation, or with the effort, during the two and a half years that the patient remained under observation.

The Results.—In 30 cases of colopexy non-recurrence is stated in 22, partial recurrence in 3, and recurrence in 4. Not a single death, and no other sequels except a hernial protrusion in one case, is reported. No comments bearing on the facts of annoyance or suffering of any kind during convalescence are expressed.

Tuttle's Sigmoidopexy.—Put the patient in the Trendelenburg position; make a longitudinal incision through the left rectus muscle, beginning two and a half inches above the pubis and extending upward; strip the parietal peritonæum laterally half an inch on either side at the lower portion of the wound; reduce the prolapse, pull the sigmoid upward until it suspends the rectum in its normal location, and in this position of comparative tension sew the longitudinal muscular band of the sigmoid to the lower inch and a half of the wound in the transversalis fascia. Stitches of fine silk or chromicized catgut are used, each of which is passed through the edges of the transversalis fascia on either side and between them through the longitudinal band. The remainder of the wound is closed by tier-suturing.

The Remarks.—The foot of the bed is elevated for five days and the bowels are moved on the seventh day.

FIG. 1426.—The introduction of bulbous bougie into the rectum.

The Results.—Tuttle has performed this operation in seven cases of prolapse with no recurrences. Some of the patients complained of a dragging pain at the site of the adhesion.

Introduction of Bougies, etc., to the Rectum.—Empty and cleanse the rectum and place the patient in either one of the three positions for rectal

examination (page 1195); inject into the rectum an ounce or so of sterilized oil; grasp and carry the bougie (Fig. 1426) from behind forward toward the navel along the anal axis, then change the direction to backward and upward, until the instrument strikes the hollow of the sacrum, then direct the point forward to take the curve of the sacrum, and finally to the left in accordance with the directions of the respective curves (page 1194), without the use of force.

The Remarks.—The introduction directly upward into the anus of the point of a syringe encroaches painfully on the superior wall of the anal
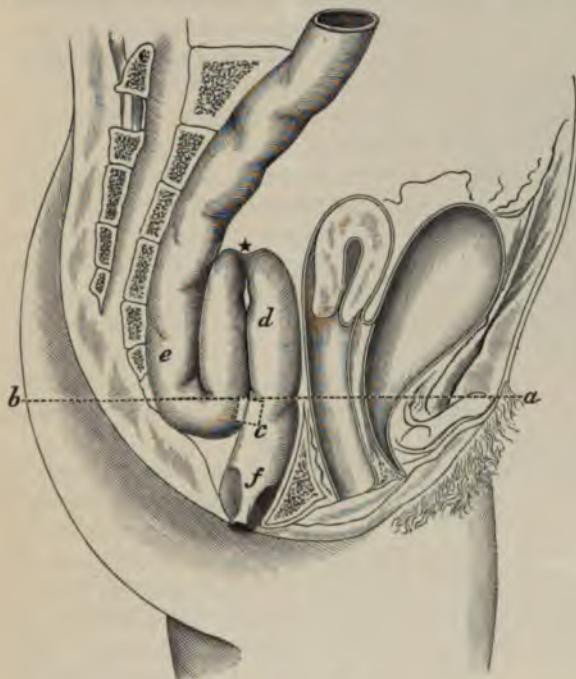
FIG. 1427.

FIG. 1428.

FIG. 1427.—Operation for stricture of the rectum, Bacon's method. *a, b.* Upper limit of levator ani muscle. *c.* Anastomotic opening between rectum and sigmoid flexure. *e.* Sigmoid flexure. *d.* Rectum. *f.* Anus. * Seat of stricture.

FIG. 1428.—Operation for stricture of the rectum, Bacon's method. Spiral instrument for insertion of female segment of button.

curve, and the point is often arrested by it. The intrarectal folds not infrequently arrest the upward course of the bougie, requiring a change of direction to effect further admission. In normal conditions the bougie will pass up to near the middle of the sigmoid flexure. If this portion of the intestine or its mesentery be unusually long the end of the instrument may be felt beneath the skin in the hypochondriac region. High injections are introduced with the patient in the knee-elbow position or while lying on the side with the pelvis elevated. Rubber instruments, or those having a rubber tip, are preferable, since there is less danger of injury from their use. The
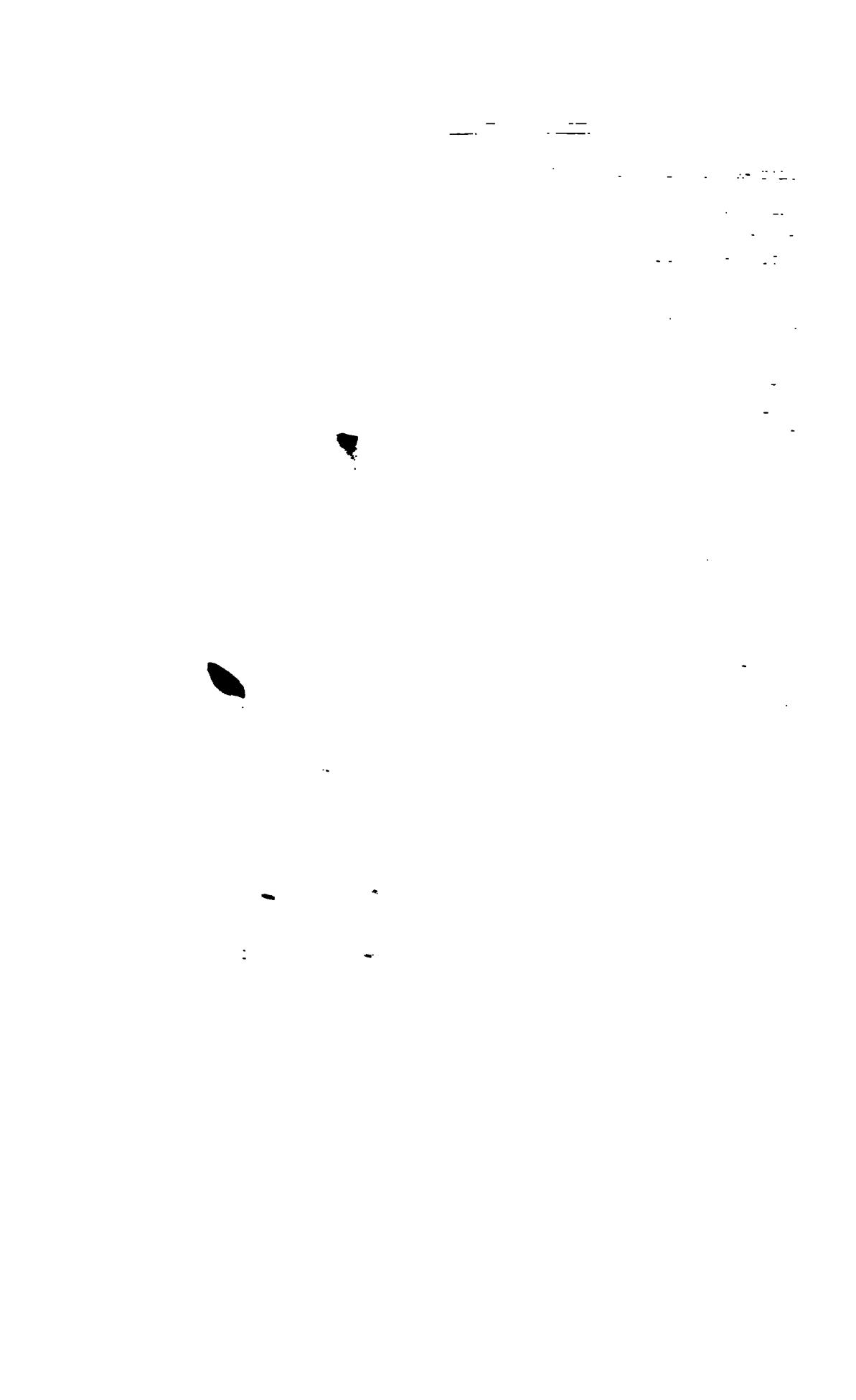
flexure (Fig. 1427); locate the seat and extent of the strictured part (*); estimate the proper site of anastomosis by applying the sigmoid flexure (e) to the rectum (d) below the seat of stricture; draw the sigmoid flexure up into the wound and introduce into it in the usual manner the male segment of the Murphy button; return it to the selected site for anastomosis and introduce the female segment of the button through the anus (f) up to the lower limits of the stricture by means of a special trocar-pointed instrument (Fig. 1428) so constructed as to deposit the shank of the segment in the channel caused by the perforation of the trocar; lock together the respective portions of the button in the usual manner; stitch the previously scarified contiguous serous surfaces of the intestine closely together (c, c, Fig. 1429) to prevent the small intestine from slipping between them. After escape of the button wash out thoroughly the rectum and colon, and introduce as indicated in the illustration (Fig. 1429), a suitable clamp, which is caused to grasp the contiguous surfaces and is tightened from day to day until the septum is destroyed and the spur removed.

The Remarks.—The button is usually expelled during the first week. The largest sized button is the best for the purpose. The septum is severed by the clamp at the

FIG. 1430.—Operation for low stricture of the rectum, Bacon's method. a, b. Separation of wall of gut (e, d) after incision through "continuous tract" (f).

end of the third or fourth day. Strict asepsis is demanded throughout. The special instrument for depositing the female half may be extemporized.

The Precautions.—If the small intestine should slip between the folds the application of the clamp will cause prompt and complete intestinal obstruction. Therefore, early and perfect apposition is sought for by means of scarification and suturing.

The Results.—A sufficient number of successful cures are noted to commend the method in suitable cases.

Bacon proposed somewhat later the following plan for the treatment of stricture located just above the internal sphincter: With the patient under anæsthesia, and the rectum thoroughly cleansed, puncture the posterior wall just above the internal sphincter with an aneurism needle armed with a heavy silk ligature (Fig. 1430); carry the point of the instrument back into the perirectal tissue behind the stricture, thence upward and through into the bowel above the upper limit of the stricture. The needle is withdrawn, leaving the ligature surrounding the stricture and with both ends hanging from the anus. The ends are tied together and the loop kept in place for " about three months " to secure a " continuous tract " (f), after which the suture is withdrawn, a grooved director inserted along its course, and the intervening tissue divided freely with the cautery into the rectum, thus severing the stricture.

The Remarks.—The idea is to establish, by means of the fistula, a tract which will remain pervious, after division of the intervening tissues, thus preventing their union and the subsequent return of the constriction.

The free drainage prevents infection and little or no annoyance attends the treatment. The patient is usually kept in bed a week after the insertion of the seton and another week after division of the stricture.

The Results.—*Bacon* reports several cases as "apparently cured" and three as "partial failures." He accounts for the latter because of failure to include with the ligature all of the scar tissue above and below the constriction. The real merits of this plan consist in the simplicity and the avoidance of division of the sphincter and its consequent annoyances.

Hartmann advocated for treatment of difficult stricture dilatation of the anus, the seizing, pulling down, and isolation of the stricture, followed by section of the rectum and union of the superior extremity to the integumentary border.

However, it appears that at the end of a few days the stitches cut out and the upper end ascends somewhat, but not sufficiently to materially affect the results. A tube surrounded with iodoform gauze should be introduced and kept in place by gauze and a perineal bandage.

The Remarks. *Hartmann* highly commended this plan because of its rapidity, simplicity, and the slight injury it causes. We are not disposed to regard it in the same light, except, perhaps, when the stricture is so close to the anus as to render the division of serous membrane impossible, and, too, when the accepted retraction is not followed by subsequent stricture formation.

External Proctotomy (*Linear or Posterior Proctotomy*).—In external proctotomy the rectum is opened from behind for the removal of foreign bodies and tumors, and for the division of malignant stricture.

The Operation. Prepare and place the patient as before; open the bowel completely, from and including the anus upward and backward even to the coccyx, with the écraseur, galvano-cautery, or the knife. The knife is employed most frequently, and in either of the following manners:

a. Expose the lower part of the stricture by cutting through the tissues behind and below the stricture with an ordinary scalpel, and then divide the stricture completely.

b. Pass through the stricture a sharp-pointed curved bistoury or ordinary scalpel; turn the edge backward at the median line posteriorly and cut directly through to the external wound. Ligature the bleeding points; pack the wound firmly with iodoform gauze to check oozing and prevent infection. The wound is dressed as often as cleanliness requires.

The Remarks. The division can be made from without inward with almost equal facility. Posterior proctotomy provides ample drainage and a full opportunity to secure cleanliness, both of which are denied by incomplete internal incision.

The Results. The death rate from this practice is not insignificant, and the duration of life following operation is about 100 days. Whenever this disease can be removed and equal comfort assured by other means proctotomy should not be practiced.

Proctectomy.—Proctectomy signifies partial or complete removal of the rectum, and as a curative or palliative measure is, at the present time, a generally accepted surgical procedure. It can be stated as a conservative precept, however, that if the upper limit of the growth can not be easily reached with the index finger, its removal should be contemplated more seriously, owing to the contiguity of the peritonæum. Still, even under these circumstances, if the mucous membrane only be involved, the diseased structure can sometimes be stripped off without entering the peritoneal cavity. If contiguous viscera be involved, or the pelvic lymphatic glands be enlarged, the expediency of the operation is decidedly questionable. The presence of ulceration, stricture, or cancer may call for the operation. When done through the *perinæum*, through the *sacrum*, or through the *vagina*, it is called *perineal, sacral,* or *vaginal proctectomy*, respectively.

The Anatomical Points.—Between the rectum and the base of the bladder in the male, and the posterior vaginal wall in the female, there is a fibrous compartment, the prerectal space, about two inches in height, filled in with a delicate areolar tissue and limited above by the peritoneal pouch, which, when opened, offers an easy separation before the entering finger (Fig. 1401, *U*). The structures below this space, attaching the bowel anteriorly in the median line in the male, are the recto-urethralis muscle, the recto-vesical fascia covering it, muscle fibers associated laterally with the levator ani which cover the recto-vesical fascia and converge to form a septum by their insertion into the central tendon of the perinæum, and the anterior attachments of the external sphincter. Behind the recto-urethralis muscle and at the base of the triangular ligament the rectum is easily separable. Lusk * has found that the longitudinal coat of the rectum sometimes has an attachment around the apex of the prostate, which, when present, must be divided in order to enter the space at the base of the bladder. Gosset and Proust's † method of approach to the base of the bladder aims at getting beneath the central tendon of the perinæum guided to it by the accelerator urinæ and transverse perineal muscles, then dividing transversely the recto-urethralis muscle, finding the rectal wall lying above the recto-urethralis muscle, and stripping it back from the triangular ligament. The peritoneal pouch can be stripped up from the front of the bowel for about two inches, which is of importance in perineal excision of the rectum. The antero-lateral attachments of the rectum (Fig. 1401) which are cut in rectal excision are the anterior fibers of the levator ani (*M*), the recto-vesical fascia (*P*) passing down from the sides of the prostate and vesicules seminales (*W*) to surround the rectum, and the fascia lining the prerectal or infravesical space (*U*). Beneath the recto-vesical fascia at this situation are found the middle hæmorrhoidal vessels (*S =* the artery), which are tied in perineal protectomy. The fascia covering the rectum posteriorly is connected to the front of the sacrum by two longitudinal folds attached on either side just internal to the anterior sacral foramina, which meet below in a point at the apex of

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* Medical and Surgical Report of Bellevue Hospital, i, 1904.
† Bull. de la Soc. Anat. de Paris, lxxvii, 1902, p. 425.

hæmorrhage. The rectum has now been made to descend about 12 to 14 centimeters (4.8 to 5.5 inches) below the plane of the perinæum, and it is held further only by its peritoneal attachments and the meso-rectum. Open the *cul-de-sac*, clamp the tissues on either side of the bowel as close as possible to it (Fig. 1433), and free the bowel by dividing the tissues between it and the clamps. Sufficient of the bowel has been drawn down when the healthy portion of intestine above the seat of disease reaches the posterior angle of the perineal wound without strain on it. Close the
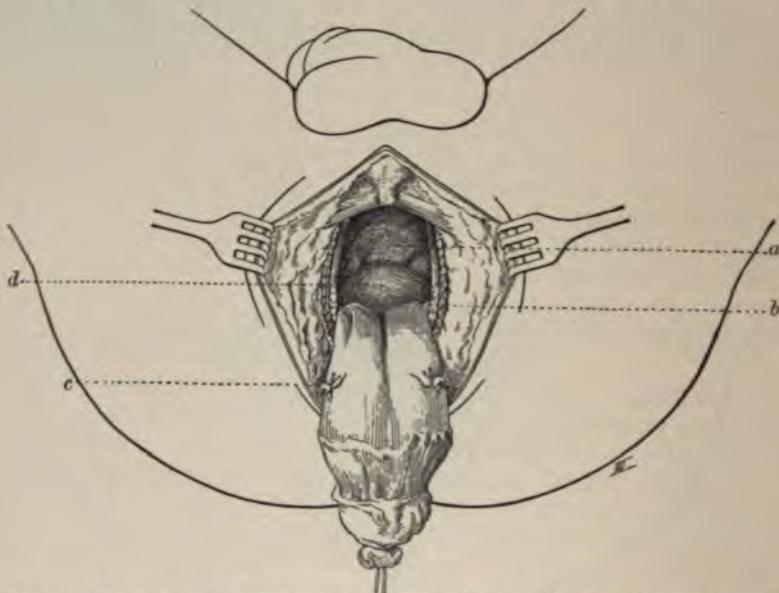
Fig. 1432.—Operation of perineal proctectomy, Quénu's method. Showing the anterior portion of rectum detached. *a.* The prostate. *b.* The levator ani. *c.* The middle hemorrhoidal vessels. *d.* The peritonæum.

peritoneal opening by suturing the anterior flap to the colon; draw together the remains of the levator ani and the recto-vesical fascia, so as to cover the posterior surface of the prostate or vagina. Pack the perineal wound with gauze and incise the anterior wall of the rectum, now hanging outside of the wound, and irrigate the bowel through the iliac anus to remove cancerous *débris* and clots. Amputate the rectum a little below the perineal wound and well above the tumor, layer by layer, catching the bleeding points as they occur; fix the end of the bowel a little in front of the posterior angle of the wound; close the wound in front and behind the site of fixation of the end of the bowel, introducing drainage.

The Remarks.—This technique applies to all cases of cancer of the rectum. It permits the extirpation of the rectum aseptically, or at least reduces the chances of infection to a minimum. It allows a methodical separation in plain view of the perineal tissues which attach the rectum to the urethra, the bulb, and the prostate; the sacral glands are easily removed, together with the tumor. When the prostate is involved in the cancer a

sound can be introduced into the urethra and a transverse slice of the prostate removed externally to the urethra channel. If the vesicules seminales are involved in the disease, they likewise can be extirpated. In the female the division of the ano-vulvar rhaphe can be facilitated by the introduction of a finger into the vagina and the dissection of the tissues toward its posterior surface; also in this sex when the pyramidal space is exposed the lateral septum on either side of it should be cut very close to the vagina. The needless sacrifice of any part of the rectum or anal margin should be avoided for obvious reasons. A malignant growth within the rectum of the male should be located not higher than four inches from the anus, and in the female not higher than three inches anteriorly, for the purposes of efficient removal by the perineal route. The prostate body and contiguous tissues are slowly invaded, but the vagina and uterus are quite promptly involved by malignant extension from the rectum. The suturing of the end of the divided gut to the tissues below hastens healing, lessens the area of exposed raw surface, and diminishes the tendency to stricture. If infection happens above the line of sewing, drainage and cleanliness should be
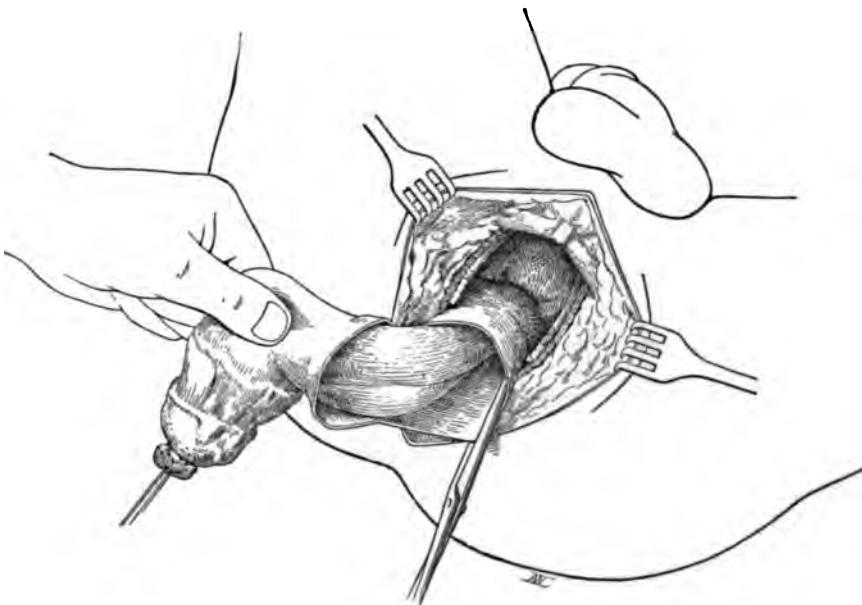
Fig. 1433.—Operation of perineal proctectomy, Quénu's method. Showing peritoneal cul-de-sac opened and connection clamped. Bowel and peritoneal covering exposed.

secured, aided by removal of one or more and perhaps all of the sutures. Sutures thus employed should be carried deeply and caused to eliminate as much as possible the presence of dead spaces.

The Precautions.—Carefully avoid injury of the vagina in the female, and of the urethra in the male; notice if the peritoneal cavity has been opened, and if so, repair it by sewing, if possible, otherwise introduce a

gauze tampon; with care, little danger from this involvement need be feared. Retention of urine is likely to follow the operation. All diseased tissues should be removed if practicable, otherwise the operation will be of but little use and possibly do much harm.

The Results.—Quénu reported 13 cases with 2 deaths, 1 from sepsis and 1 from gangrene of the gut.

Abdomino-perineal Sigmoido-proctectomy (*Quénu*). *First Step: The Incision and the Ligature of the Internal Iliac Arteries.*—Place the patient in the Trendelenburg position; make a median incision, pack off to the left side the diseased bowel, and through an incision in the peritonæum ligature the right internal iliac artery, avoiding injury to the ureter (page 135, vol. i). The left internal iliac artery can then be ligatured through an incision in the peritonæum passing first through the base of the mesosigmoid, but it is easier to leave the tying of this vessel until after the sigmoid loop has been divided. Explore the course of the iliac vessels, especially at their bifurcations, for suspicious glands; close the right peritoneal incision.

Second Step: The Liberation of the Sigmoid Loop and Formation of a Left Iliac Anus.—Place gauze pads all around the sigmoid, make a hole in the mesosigmoid opposite the site of proposed section of the bowel, avoiding the vessels; strip the bowel contents back, ligature the gut here with two ligatures of strong silk placed several centimeters apart, and then divide the intestine with a cautery between the ligatures, having first made sure that the proximal end will be of sufficient length to be brought outside of the abdomen without too much tension for the formation of the iliac anus. Dry the extremities of the divided gut, then cauterize them and tie over them rubber or gauze. Between two clamps continue the liberation of the intestine from above downward along the mesosigmoid. Bring the proximal extremity through a left iliac incision, suturing its serous surface to the parietal peritonæum at the opening, at three or four points.

Third Step: The Liberation of the Rectum.—Incise any remaining mesosigmoid on either side, and then carry the distal extremity of bowel forward taut over the pubis, thereby bringing into a cord-like prominence the superior hæmorrhoidal vessels, which tie. Raise the rectum from the front of the sacrum down to the tip of the latter, and if easy of access incise anteriorly the peritoneal pouch. The cut edges of the mesosigmoid may be sewed together. Having made sure that the distal extremity of bowel is well covered and protected, place it in the pelvic cavity and over it put one or two gauze pads and close the abdominal wound.

Fourth Step: Perineal Extirpation.—Put the patient in the lithotomy position, recleanse the operative field, and extirpate the rectum in the manner already described under perineal proctectomy (page 1220), removing the whole excised lower end of intestine, together with the gauze pads above it.

The Precautions.—In ligating the right internal iliac artery the ureter is found directly under the peritonæum. An incision in the peritonæum at the side of the promontory, a little internal to the pulsating vessels, should avoid the ureter, leaving it in the external flap of peritonæum. The left ureter lies deeper than the right, the inferior mesenteric vessels

intervening between it and peritonæum. The external iliac artery should be located before the internal iliac is tied. The abdominal wound should be sealed up to prevent its possible infection from the artificial anus.

The Remarks.—The internal iliac vessels were first ligatured in this operation by David Giordano. The resulting hæmostasis is so complete that about ten inches of intestine can be removed without using a ligature except for two or three veins. The proximal end forming the artificial anus is left closed by the thread tied around it as long as possible after the operation. Where the seat of disease is above the sphincters, *Ball* recommends tying off the bowel above the recto-vesical fascia, dissecting out the mucous membrane down to the anal margin, and bringing the end of the colon out at the anus and fixing it there, after the method of Moulonguet. As to the possibility of bringing the proximal extremity of the gut to the anal margin without tension, he states that in order to do this, the division of the colon must be at the sigmoid loop, and that the mesosigmoid must have a length of about six inches. Otherwise a colostomy must be performed instead.

The Results.—Quénu collected 16 cases of abdomino-perineal excision of the rectum for cancer with a mortality of fifty per cent.

Sacral Proctectomy.—Sacral proctectomy is a procedure devised for the purpose of high removal of the rectum in cases not amenable to operation by other routes. For briefness and lucidity of description the operation is divided into three stages: 1, exposure of the rectum; 2, removal of the diseased portion; 3, the securement of the upper segment. The first stage especially is variously altered by different operators, all of which changes are, however, but modifications of the original conceptions of Kraske.

Kraske's Operation.—Administer an anæsthetic, and place the patient on the right side; make an incision in the median line from the center of the sacrum to the anus through the soft parts; detach the ligamentous and fibrous tissues from the left side of the coccyx and the sacrum as high as the third sacral foramen; disarticulate and remove the coccyx, and with a gouge remove the lower part of the left side of the sacrum in a curved outline (Fig. 1434) to a level with the lower border of the third sacral foramen; free the posterior wall of the gut from the connective tissue and muscles, and place the patient in the exaggerated lithotomy position; sever the anterior connections of the bowel; isolate carefully the parts to be removed with gauze to prevent infection; remove the diseased segment by transverse division of the gut at a distance of half an inch or so at either side of the growth; draw the bowel down from above, and join it in the usual manner to the lower segment by sewing; establish proper drainage, and prevent peritoneal infection by careful attention.

The preceding description is an abbreviated statement of Kraske's pioneer operations, which, while retaining merit, have yielded to the modifying influences of improved technique. The incision for exposure of the bowel made by Kraske has been modified by various surgeons for conservative purposes and to gain additional room. *Hochenegg* and *Badenhauer, Lery. Rydygier* (Fig. 1434), and others removed an additional amount of the sacrum.

Heinecke made an incision through the sphincter along the middle line to the tip of the coccyx, thus exposing and dealing promptly with the first part of the rectum. He then extended the incision along the median line of the sacrum to the third spine of that bone, and divided the bone in the course of the incision to a point corresponding to the lower level of the third sacral foramen. At this point right-angled incisions were made at either side through the soft and hard parts, and the triangular flaps thus formed were turned outward, causing free exposure of the rectum.

Kocher's Method of Exposure of the Rectum.—*Kocher* exposes the rectum at the left of the gluteal cleft from a point two fingers' breadths below the posterior superior iliac spine downward to and along the median line of the sacrum, coccyx, and ischio-rectal region to the posterior edge of the anus, which opening it surrounds, terminating at the rhaphe in front.

If bone is to be resected, expose the edge of the sacrum by separation from the bone of the corresponding part of the gluteus maximus; divide the ligaments and muscles attached

Fig. 1434.—The operation of sacral proctectomy, exposure of the rectum. *a, b, c.* Kraske's lines of division of the sacrum. *a, c.* Hochenegg's line of division. *a, d.* Badenhauer's, Levy's, and Rydygier's lines of division.

to the border, and separate the bone from the deeper tissues; remove respectively the coccyx, the lower part of the sacrum, or a small portion of it, or a piece extending up to the fourth, the third, or even to the second sacral foramen, as may be needed to properly expose the bowel. The coccyx is removed by means of traction made by a sharp hook applied to its apex during its disarticulation; the lower part of the sacrum by chisel and mallet. Active bleeding at this time comes from the divided bone, and the middle and lateral sacral arteries. The arteries lie so closely to the sacrum that ligature is difficult, and plugging may be required to arrest bleeding. The inferior hæmorrhoidal vessels suffer with division of the sphincter and the tissues associated with the anal end of the rectum.

If bone is not to be resected, detach the greater and lesser sacro-sciatic ligaments from the edge of the sacrum and both edges of the coccyx; divide

the pyriformis, the coccygeus, the levator ani below the apex of the coccyx, and the external sphincter, from above downward.

To expose the rectum higher up, separate its connections from the sacrum and the coccygeal muscles and ligaments; divide the peritonæum at either side of the gut at the posterior wall of Douglas's *cul-de-sac;* ligature branches of the middle and superior hæmorrhoidal arteries during higher separation of the rectum; divide the presacral fascia; draw down the rectum with a blunt hook after division of this fascia, and ligature the lateral and posterior vessels; divide the prerectal fascia, thus exposing the prostate, vesiculæ seminales, lower ends of the vasa deferentia, the base of the bladder, and the lower end of the ureter a little to the outer side and upper end of the vesiculæ seminales.

In movable carcinoma of the rectum within the reach of the finger, divide the integument, subcutaneous tissue, and muscular fibers from the anus to the sacrum; free the rectum laterally by passing the finger along either side of the gut, hooking up and cutting between ligatures the vascular bands encountered; grasp the rectum above the anus and pull downward upon it, increasing the displacement by division of its sacral connections; draw the growth downward and outward, and divide the muscular coat only, an inch or an inch and a half above the growth, and ligature the vessels; tie a strong silk ligature round the gut above the point of division of the muscular coat, and divide the mucous membrane below the incision with a thermo-cautery; separate the diseased portion with the mucous membrane downward as far as the anus, and remove it, using care to prevent infection; pull down and suture the tied part of the rectum to the freshly pared muscular margin of the anus. Cleanse the lower end of the rectum and stuff it with gauze.

The Remarks.—*Ball's* observations (page 1225) on the conditions under which the proximal extremity of the divided gut can be brought to the anal margin without tension, would apply here.

Tuttle exposes the rectum as follows: Place the patient on the left side with hips on a hard pillow in Sims's position, and with the legs well flexed; make an incision at the left side about half an inch from the margin of the sacrum, beginning at a point opposite the third sacral foramen and extending down to the tip of the coccyx; carry the incision through the sacrococcygeal ligament into the cellular tissue behind the rectum; detach the rectum from the anterior wall of the sacrum with the fingers; make a transverse incision at the upper limit of the first incision across the sacrum down to the bone; divide the bone transversely with a chisel and turn the flap to the left, thus exposing to view the rectum. *Tuttle* lays stress upon the control of hæmorrhage by rapidly exposing the rectum and clamping it with a long-jawed forceps before attempting to dissect it out.

Levy's Method of Exposure of the Rectum.—Make a transverse incision across the sacrum a finger's breadth above the cornua of the coccyx (Fig. 1434) down to the bone, and extend it at either side of the coccyx in a curved direction, parallel with the fibers of the gluteus maximus to within two inches of the tuber ischii; separate the fibers of the gluteus maximus at either side and draw them apart; locate the fourth sacral foramen; expose

and divide the sacro-sciatic ligaments carefully on a director in a line with the original incision down to the margin of the sacrum at either side; separate the parts in front of the sacrum along the line of the horizontal incision; introduce a chain saw and divide the bone from within outward; turn down over the anus the osteoplastic flap, thereby exposing the posterior rectal region to view. This plan is not regarded with special favor.

Rehn-Rydygier's Method of Exposure of the Rectum.—Make an incision from the posterior superior spine of the ilium downward, along, and half an inch from the left margin of the sacrum to the apex of the coccyx, thence along the median line to near the anus if necessary (Fig. 1435). Expose the margin of the sacrum at the upper end of the incision; locate

FIG. 1435.—The operation of sacral proctectomy, Rehn-Rydygier's method. *a.* Posterior superior spine of ilium. *b, c.* Transverse incision. *c, d.* Incision at left border of sacrum, etc.

and divide the greater and lesser sacro-sciatic ligaments; make a transverse incision across the posterior surface of the sacrum two fingers' breadth above the sacro-coccygeal articulation; raise the soft parts from the anterior surface of the sacrum below the third sacral foramen; saw or chisel through the sacrum transversely in the line of the incision; turn the osteocutaneous flap to the right, and expose the posterior rectal region. This plan is regarded with special favor.

Borelius's Method of Exposure of the Rectum.—Place the patient on the right side with the knees drawn up and the pelvis raised. Make an incision in the median line from the tip of the coccyx to a little above the middle of the sacrum down to the bone; make a second incision from the beginning of the first along the lower border of the left gluteus maximus muscle; separate the flap from the sacrum and draw it aside; raise the tissues of the right border of the wound sufficiently to permit the division of the sacrum obliquely downward from left to right below the third (left) and fourth (right) sacral foramen; free the bone flap sufficiently to

permit it to be turned to the left, thus exposing to view the posterior rectal region.

The Remarks.—Since the third sacral nerves are concerned largely in the motor function of the rectum and bladder, it is unwise to invade the third sacral foramen needlessly, as paralysis of these viscera may result from injury to the nerves. However, Kocher states that the division of the sacrum may be extended up on *one side* as far as the second sacral foramen without permanent loss of power of the rectum and bladder, because of the integrity of the nerves of the opposite side. General practice commends the exposure of the third and fourth sacral foramina, the drawing aside of the corresponding nerves, and transverse division of the sacrum just below the third sacral foramina. An oblique section of the sacrum of proper dimensions removes in any instance one fourth sacral foramen. The division of the sacro-sciatic ligaments at the border of the sacrum exposes to danger the pudic vessels and nerves. In no instance should the bone flap be replaced and fastened in position unless proper union of the divided bowel is assured. The normal support given the rectum and pelvic contents by the sacrum is not much impaired.if the bone flap be restored to its normal relations with the contiguous tissues. Operations that limit the extent of the bone excision to a minimum limit likewise the opportunity of inspection and manipulation of the diseased part, which are of greater significance than is the diminished support incident to liberal resection.

The Second Stage (Removal of the Diseased Portion).—The rectum is dissociated from surrounding tissues by means of blunt dissection with the fingers, grooved director, blunt-pointed scissors, etc., attended by prompt arrest of hæmorrhage by ligature and gauze packing. If the peritoneal cavity be opened into inadvertently or otherwise, the wound is promptly closed by suture or tamponade, depending on the reason for the infliction of the injury and the presence of infecting agencies. Careful protection with gauze should be given the peritonæum and other tissues during removal of the diseased part. The limits of the disease are determined by external manipulation of the bowel, or, if need be, internal digital examination conducted through an opening made into the gut near the locality of the disease. The diseased part is removed by use of the scissors, cautery, etc. The removal of the diseased segment is followed quickly by cleansing of the wound and closure of the peritoneal openings by sewing when possible. The bringing down to the proper position for union of the upper segment, especially in high division, must be so conducted as not to impair the nutrient vessels of the mesentery and cause gangrene of the gut. *Gerster* emphasizes the importance of cautious technique in the following well-chosen words: "Where high amputation is to be performed, the surgeon must try sedulously to preserve the nutrient vessels of the mesentery, otherwise the entire rectal stump may mortify. This will be found most difficult in that part of the rectum which adjoins the flexure. Lateral incisions through the peritoneal attachments are permissible, but cutting into the mesenteric line itself will certainly be followed by disaster. Adequate lateral incisions will permit the surgeon to peel up the gut from the sacrum by the gentle use of the finger tip. The higher this detachment of the gut

... encountered in drawing down
... the external incision, espe-
... moved. A few stout silk
... laterally will serve
... wound remaining open.
... best to stitch up
... incautious manipu-
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... arning

of the growth at the junction of the sigmoid and rectum, or in the event of recto-sigmoid intussusception. It will not be amiss to emphasize the importance of the measure in the latter condition by reference to the illustrative case reported by Hartley.

" The tumor was exposed through a liberal median incision with the patient in Trendelenburg's position, and raised upward out of the pelvis as far as possible, and surrounded with gauze. An incision three inches in length was made over the lower segment entering the intestine—intussuscipiens (Figs. 1041 and 1044); the tumor and intussusceptum were delivered through this opening after protecting the mass with additional gauze. The intussusceptum was then divided transversely a little below its neck. The divided ends were held in position until the arteries in the mesenteric border were securely ligated. Silk sutures were then passed through all the coats of the intestines as they were held in position, according to Maunsell's recommendation, and tied (Fig. 1046).

" One or two catgut ligatures were placed in the mucous membrane along where it gaped. The fold was then reduced, and a Lembert suture was carried around the intestine above the larger and deeper sutures. After this, the longitudinal incision in the lower segment was sutured by a few stitches of silk in the mucous membrane, and a Lembert suture in the serosa and submucosa. The cavity was wiped out with a sponge. The abdominal incision was closed with silkworm gut." The recovery in this case was prompt and uneventful.

Murphy's button can be made to exercise an important function in suitable cases of resection of the rectum. It should not be regarded, however, as a suitable substitute for the Kraske method of practice only in exceptional instances. It is employed in the following manner: Dilate the sphincter widely; draw down with forceps the diseased process; insert in an out-and-in manner through the wall of the bowel below the disease the puckering string; divide the bowel transversely a quarter of an inch above the string; seize the proximal segment with forceps and draw it down into the distal, while separation above is being made with the fingers; insert an inch above the disease another puckering string and divide the rectum half an inch below it, thus removing the disease; introduce the male portion of the button into the upper segment, and fasten it in place with its puckering string, which is then cut short; pass the female portion of the button up over the distal string until it catches the end of the male cylinder sufficiently to hold it in place; make a small parallel incision into the lower segment of the rectum over the coccyx and half an inch below the first puckering string; pass through the opening a strand of iodoform gauze for drainage, allowing it to remain in place for three or four days; draw the button into the distal end, confine it with the puckering string, which is cut short, and the segments of the button are then approximated. Since normally the contents of the lower colon are formed, the bowels are kept loose during the presence of the button in the rectum to avoid faecal impaction. The button may be expected to come away on the tenth or twelfth day. The impossibility in many instances of removing all the disease, the limited space of action, the absence of a complete peritoneal covering of the

intestinal ends, and the difficulty in securing proper adjustment of the segments of the button are among the obstacles that unfit the appliance for general use.

The General Remarks.—*Quénu*, through a low colostomy, carried a solid sound, grooved at the end, down to within an inch of the growth, ligatured the bowel firmly in the groove, divided the gut, and slowly withdrawing the sound invaginated the rectum and fastened it to the wound above. *Keen*, after preliminary colostomy and removal of the disease, advises sewing up and dropping back into the sacral wound the cut end of the rectum and closing the perineal wound. Dividing or stretching the sphincter should be done in cases of extended disease; the latter is never amiss in enterorrhaphy or union by the Murphy button as a preventive measure of fistula. The hæmorrhoidal branches of the gut lie so closely in contact with the muscular wall that they are readily displaced along with the bowel, and for this reason are not injured if the mesocolon be divided close to the sacrum. The division at either side of the bowel of the peritonæum which holds it in place should be carefully practiced with scissors, to prevent injury of the contiguous vessels and obviate the danger of necrosis of the stump. The extent of the peritoneal division will be governed by the height of the growth in the bowel, and the degree of downward displacement required to secure proper adjustment of the stump without tension; if the disease be too extensive for removal the bone flap should be replaced and fixed in position. Careful enucleation of the disease should be practiced, as perforation, infection, and free bleeding will otherwise be caused, and after enucleation the closure of peritoneal wounds by sewing or gauze should be promptly made. Two iodoformized gauze ligatures may be carried around the bowel about an inch above the growth, the intestine severed between them with scissors, and the divided ends cleansed and wrapped in gauze, to prevent infection. *Quénu* and *Hartmann* regard free and easy access to the rectum and absolute asepsis as necessary to the attainment of the highest outcome. The introduction of the finger into a cleansed rectum during operation is earnestly opposed by these authorities. *Kraske*, of Freiburg, through an abdominal incision ties and severs the superior hæmorrhoidal artery between two ligatures, then divides and separates the rectal peritonæum, removing the enlarged lymphatic nodes in mesocolon and mesorectum without loss of blood. The anus should be placed in the sacral wound, if tension be too great to permit proper adjustment elsewhere of the upper segment, and liberal release above of the bowel should be made before union below is attempted. The wound should be packed with gauze, which is changed within forty-eight hours if fæcal escape be feared. In any instance it is dressed afterward as often as cleanliness demands. When granulation becomes well established, the patient can be up and around, and thus get the benefit of fresh air and returning confidence. In the instance of an anus of defective retaining force, a close-fitting pad should be worn

The Choice of Operation.—Cancer of the rectum, like similar growths elsewhere in the body, may be treated radically whenever it is technically possible to remove the disease and the patient's condition warrants the at-

tempt. The fact of contiguous involvement need not contraindicate the attempt, provided the preceding indications are available. The perineal method is suitable in those cases in which the disease is within easy reach, well defined, and the lumen of the gut amenable to proper control. Parasacral incision, with removal of the coccyx and perhaps without, affords ample room for the employment of the perineal method. Those cases in which the disease is located higher up than for the preceding method of attack are suitable for approach by the sacral route. *Krönlein* believes that the sacral route of approach should be reserved for removal of disease of the upper part of the rectum. *Mathews* regards the sacral route as dangerous, difficult, and unpromising. Many English surgeons share in this opinion, and limit their efforts to the availability of the perineal operation. When the disease involves an area extending from the anus or lower rectum upward into the sigmoid, the abdomino-perineal method is indicated.

The Results.—Incontinence of fæces, fistula, stricture, and prolapse constitute the prominent sequels of the operation. If the sphincter be removed and the levator ani be greatly impaired, but little control will be had of the intestinal contents. However, the command is better if the bowel be not, than if it be, sutured to the skin under these circumstances, as in the former method greater cicatricial change will take place. It appears, so far as definitely stated, that complete incontinence of fæces happens in about 6 per cent, partial in about 9, and satisfactory control in the remainder of the cases. *Fistula* results from imperfect union dependent on tension, defective sewing, infection, etc. Many fistulæ heal quite promptly with the use of bougies and proper cleanliness; others require special operation for cure. *Stricture:* Every form of union of the segments is (1 in 10) liable to be followed by stricture at the seat of junction. The knowledge of this liability should be forestalled by frequent inspection and a discreet use of bougies. *Prolapse* of the rectum (rare before Kraske's method) is the outcome commonly of impairment of the sacral floor; therefore the importance of this defect should be heeded and the meso-rectum should be thoroughly repaired. The general death rate of the sacral method of operation is from 18 to 25 per cent. The final outlook in highly favorable cases is gratifying, as 75 per cent of Kocher's operative recoveries were alive and well four to sixteen years after operation; 62 per cent of Czerny's cases were free from disease when reported, a third of which were of two years' standing. *Hochenegg* reports the operation mortality in his cases at 8.2 per cent, and the cure at 25 per cent. He no longer operates for recurrence. *Krönlein* has collected 881 cases, from German sources, of extirpation of the rectum by the radical method, showing a rate of mortality of 20 per cent and cure of 14.30 per cent. He concludes that the best functional results follow when the proximal end of the gut is caused to occupy the normal site of the anus, and when the sphincters are preserved; also that the removal of all the rectal structures does not increase the rate of permanent cure and is followed by the worst of functional results.

In *Tuttle's* late and exhaustive paper appears the following instructive facts bearing on this topic, based on the results in about 600 cases here and abroad:

FINET'S SYNOPSIS OF CASES.

Immediate deaths.. 66
Deaths under 1 year, cause not given, 8; deaths between 1 and 2 years,
    3; deaths between 2 and 3 years, 1........................... 12
Deaths from recurrence *in situ*, under 1 year, 17; metastasis under 1 year,
    12; *in situ*, between 1 and 2 years, 2; metastasis between 1 and 2
    years, 1; *in situ*, between 2 and 3 years, 3; metastasis between 2
    and 3 years, 1.. 36
Living with recurrence under 1 year, 18; under 2 years, 1; under 3
    years, 1; over three years, 2.................................. 22
Living without recurrence under 1 year, 124; under 2 years, 11; 3
    years, 23; 4 to 5 years, 10; 5 to 6 years, 7; 6 to 7 years, 6; 7 to 8
    years, 5; 8 to 10 years, 5; 10 to 11 years, 3; 11 to 12 years, 1; 12
    to 14 years, 1; 14 to 15 years, 2; 15 to 16 years, 1; over 16 years, 2. 201
Died without recurrence after 4 years, 4.............................. 4
        Mortality, 19 per cent....................................... 341

TUTTLE'S SYNOPSIS OF CASES.

Immediate deaths 31
Deaths under 1 year, recurrence *in situ*, 8; by metastasis, 6; between
    1 and 2 years, recurrence *in situ*, 4; by metastasis, 3; between 2
    and 3 years, recurrence *in situ*, 4; by metastasis, 2; after 3 years,
    recurrence *in situ*, none; by metastasis, 1...................... 28
Living with recurrence under 1 year, 6; between 1 and 2 years, 5; 1
    each 2, 4, 2, 2, 2½, 4 years.................................... 17
Living without recurrence under 1 year, 90; over 1 and under 2 years,
    48; over 2 and under 3 years, 20; over 3 years, 23.............. 181
        Mortality, 11.7 per cent.................................... 257

Sacral, 173 cases, 23 deaths; mortality, 13.3 per cent. Perineal, 70 cases, 5 deaths; mortality, 7.1 per cent. Vaginal, 1 death; anal, 1 death; not given, 1 death.

Vicarious Sphincteric Control.—The possibility of vicarious or normal control of the end of the bowel is a very important element of comfort and satisfaction to the patient and friends in determining whether or not to submit to operative procedure that contemplates the loss of the control of fæcal discharge. In this connection it should be noted that fæcal incontinence does not solely depend on the integrity of the sphincters, but also on that of the functions of the mucous membrane of the points of exit. Thus, when the lower end of the rectum is removed and the proximal extremity sewed to the integumentary border, this extremity is not possessed of the inhibitory power of the antecedent part, and therefore temporary incontinence may result, which later disappears, in most instances, when the divided nerve connections are re-established. In the instance of proctectomy the following expedients for better control are sometimes practiced. Carrying the end of the rectum between the fibers of the gluteus maximus at the lower or upper part, as may best suit the length of the upper segment, is an ingenious measure devised by *Willems* and others, and can be commended as a harmless effort that has been followed with beneficent results on several occasions; in certain cases the utilization of the pyriformis for the purpose is commended.

Gersuny practiced torsion of a limited part of the upper segment between two forceps, until appreciable resistance attended the introduction of the index finger, then stitched the end to the skin margin, thus securing some retentive power at the lower end. Successful instances are cited of this method.

In connection with artificial anus various measures of control of the fæcal discharge have been devised, such as the drawing of the bowel through a vertical separation of the fibers of the outer edge of the rectus abdominis (Howse), and through a vertical and oblique division (von Hacker) at some distance above the pubis, or through a vertical incision of the rectus immediately above that bone, supplemented by gouging of its upper border to provide a completer outlet (Roux). The separation (Maydl), instead of division of the muscular fibers, attended with stitching together of the arms of the loop, are important features of successful outcome in these
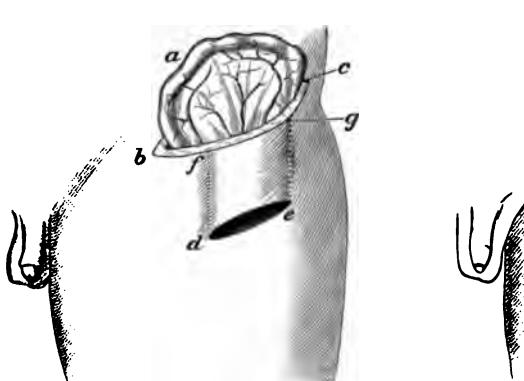
FIG. 1436.—Operation for vicarious sphincteric control. *a.* Loop of intestine. *b, c.* Opening in abdomen. *d, e.* Opening at anterior surface of thigh (Braun) for escape of intestine along channel limited by *f, d, g,* and *e.*

FIG. 1437.—Operation for vicarious sphincteric control, Braun's method. *a, a.* Proximal end of sigmoid and vicarious opening. *d.* Rectal end of sigmoid closed and dropped back into pelvis. *e, f.* Abdominal opening. *c, d.* Anal opening.

cases. The removal of the loop of intestine (Fig. 1436), the closure and dropping back of the rectal end into the pelvis (Fig. 1437), followed by transference beneath the skin of the upper end to a point below the crest of the ilium (Witzel), with or without narrowing of the end of the bowel, is admirable practice (Fig. 1438).

Lusk has made a controllable artificial anus by drawing the sigmoid loop through the incised aponeurosis and separated muscle fibers of the abdominal wall just internal to Poupart's ligament opposite the junction of its outer and middle thirds, then dividing the bowel low so as to leave the proximal loop long to serve as a fæcal container as practiced by Mayo, returning the distal end, and finally turning the proximal end upward, laying it upon the aponeurosis of the external oblique alongside of Poupart's ligament and the anterior superior spine of the ilium, to emerge through the skin just above the level of the latter point. An oval water

pad held in place by an elastic band around the crests of the ilium and one around the perinæum practically control the anus completely.

Paraffin Injections for Sphincteric Control.—*Paget* reports a case of prolapse of the bowel and loss of control following excision of the rectum, treated by injections of paraffin under the mucous membrane. Before injection, the opening admitted three fingers and the patient had control of solid movements only. The injected paraffin raised the mucous membrane at two points, one lying a little above the other, narrowing the opening so as to admit only one finger. The paraffin held up the prolapse, and made the opening valvular, so that there was no further escape of the contents of the bowel. The method of injecting paraffin is described by Lagarde.*
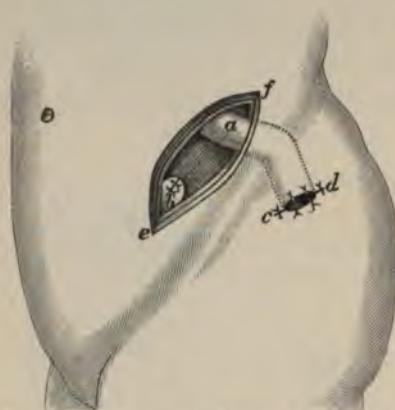
Fig. 1438.—Operation for vicarious sphincteric control, Witzel's method. *a.* Proximal end of sigmoid. *b.* Rectal end closed and dropped back into pelvis. *e, f.* Abdominal opening. *c, d.* Vicarious opening, sigmoid passing across crest of ilium.

Colorectostomy.—Colorectostomy can be practiced at the lower part of the sigmoid flexure through a median abdominal or the sacral incision. *In the former method* paralyze the sphincter by overdistention, and wash out the rectum; place the patient in Trendelenburg's position, and make an abdominal incision in the median line from the symphysis to the navel; excise the growth, if feasible, and close the distal end of the gut with sutures. If excision be not feasible, divide the colon above the growth and close the distal end as before; pass through the borders of the open proximal end six strong silk traction sutures, leaving the ends of each suture not less than ten inches in length; thrust through the anus up the rectum along its anterior wall to within two inches of the growth, or against the closed end (if the growth have been removed), a long-handled forceps or a sponge holder; make an incision an inch in length at the peritoneal aspect of the rectum down upon the instrument with a bistoury; pass the forceps through the opening and seize the twisted bundle of traction sutures; withdraw the forceps, grasping the sutures hanging from the bowel, and by gentle traction cause the "telescoping" of the upper segment through the incision in the rectum the desired distance, which should be not less than half an inch; unite with sutures at the pelvic side the infolded serous surface of the lower segment with the serous covering of the upper, if possible, holding the parts firmly by the traction sutures during the sewing (Fig. 1439). Wash out the pelvis with a warm saline solution, and adjust strips of iodoform gauze packing around the colorectal junction, allowing the ends to escape from the lower angle of the abdominal wound, the

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* Les Injections de Paraffine, Paris, 1903.

remaining portion of which is closed; if no evidence of fæcal leakage be seen at the end of four or five days, withdraw the gauze and close the wound almost entirely.

Sigmoido-rectostomy in the female was first described by Rotter,* and later by Ries † who had conceived the operation independently. It has been practiced for high stricture of the rectum.

The Operation.—Through a median incision divide the sigmoid with a cautery between two ligatures; carefully cover the proximal end with gauze and close the distal end; protect the abdominal wound with gauze, place the patient in the lithotomy position, split the recto-vaginal septum and
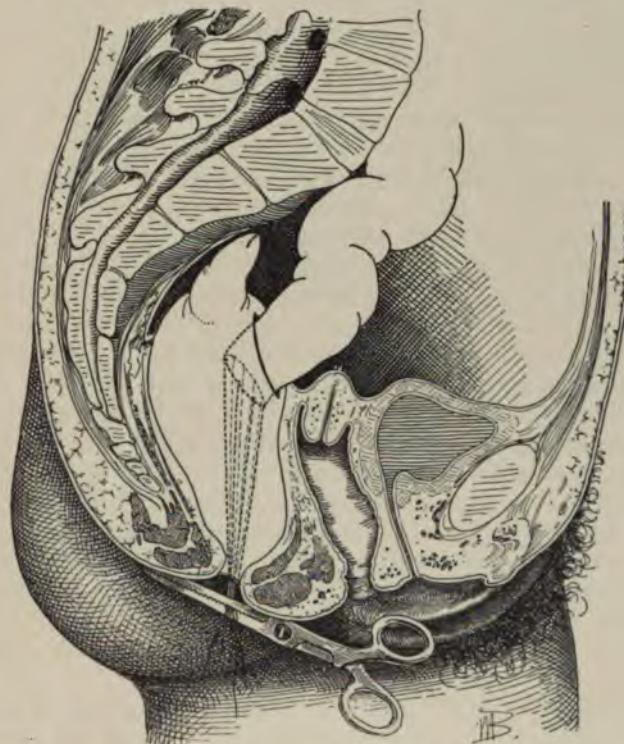
Fig. 1439.—The operation of colorectostomy. Removal of the upper part of the rectum, with the uterus, tubes, and ovaries. The union of sigmoid and rectum should be made by sero-serous sutures.

enter Douglas's pouch; after freeing the sigmoid sufficiently by nicking its mesentery, push the proximal end through the pouch of Douglas and draw it through the recto-vaginal space by threads attached to it for this purpose; close the abdominal wound; make a longitudinal opening in the rectal wall anteriorly between the sphincters and the seat of stricture; draw the

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* Archiv f. Klin. Chir., lviii, 1899.
† New York Medical Journal, December 13, 1902.

bowel into the opening and sew with the apposed edges of mucous membrane together on the rectal side through the dilated anal canal; also sew the bowel to the recto-vaginal space; tampon the recto-vaginal space with iodoform gauze.

The Results.—Rotter reported three cases with two successful results and one death from peritonitis. Ries reports one case, which was successful.

Sacral colorectostomy is quite readily done after reflection of the osteocutaneous flaps, in the same manner as with the median incision (Uhlmann). It has been suggested, in order to obviate the rectal obstruction and the formation of an artificial anus, through a median incision, to stitch a loop of sigmoid to the rectum below the seat of the disease, and make an opening at the site of union by way of the rectum, after adhesion has taken place (Bacon).

Vaginal Proctectomy.—The approach to the rectum through the vagina has a limited and as yet undeveloped availability. After the usual antiseptic preparatory treatment of the rectum, vagina, and cervix uteri, empty the bladder and tampon the rectum; make an incision in the posterior wall of the vagina from the cervix to the perinæum down to the sphincter and levator ani fibers; separate the rectum from below upward, and draw it forward at the same time; arrest hæmorrhage, and remove the necessary portion of the gut, as already described; draw the bowel down and stitch it to the borders of the wound in the usual manner; close the vaginal wound with sutures, and apply gentle coaptation compression to the seat of operation by vaginal tampon. *Heydenreich* believes that this route should be limited to those cases in which the vagina is not impaired at the point of division, and in which the disease is limited to the lower four or five inches of the bowel. He extends the incision to the coccyx, thereby forming two posterior flaps. Heydenreich claims that less shock and less liability to fistula and fæcal incontinence attend this than the sacral method. *Rehn* commends the method, practiced singly or with abdominal incision. *Quénu* and *Hartmann* prefer the perineal method, and incise the vagina only when involved in the disease.

The Results.—Eleven successful cases and one death by this method are reported.

Murphy reports * five comparatively late cases of his own of resection of the rectum *per vaginam*. After describing the steps of the operation, he states its advantages as follows:

" 1. The sacrum and posterior bony wall of the pelvis are not disturbed

" 2. The field of operation is as extensive and the anatomical parts as accessible as in the trans-sacral operations.

" 3. The peritoneal cavity is opened in both the vaginal and sacral operations, and in neither is it a source of great danger.

" 4. The diseased tissue is more accessible for inspection, and the extent to which the operation may be carried in an upward direction is as great, if not greater, than by the sacral route.

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* Philadelphia Medical Journal, February 23, 1901.

" 5. The peritonæum may be drained freely through the vagina.

" 6. A perfect end-to-end approximation, either by suture or by the use of the button, may be secured. The preferable method of uniting the two ends is by interrupted sutures of silk, because, as there is no peritonæum on the sphincteric segment, failure of union with the button is to be feared.

" 7. The sphincter is retained and the perineal body is restored. There is diminished action of the levator ani muscle.

" 8. When the operation is complete the parts are practically in their normal positions."

Anal Fissure.—The operative treatment of this condition is by *incision*, by *excision*, or by *stretching of the sphincters*.

The Operation by Incision.—Incise the external sphincter at a right angle to its fibers, either through the fissure or at a short distance from it, to a depth a little greater than that of involvement by the lesion.

The Remarks.—This method is applicable to fissures in an *early stage* before the formation of much scar tissue. The result is to temporarily paralyze the involved sphincter fibers, which allows the ulcer to heal. A fissure of this sort at either the anterior or the posterior commissure is treated by division of the external sphincter fibers at a short distance from the lesion on one or both sides, where they can be cut at a right angle.

The Operation by Excision.—Excise the fissure with its associated scar tissue and suture the wound.

The Remarks.—This method is applicable to an *old indurated* fissure. It has been practiced by *Tuttle*, and we have found it invariably attended with complete cure. *Quénu* and *Hartmann* have shown that the scar tissue of an intolerable fissure contains in its deeper layers nerve fibers affected with neuritis and perineuritis to which the pain of the lesion is attributable. Hence the cure effected by the removal of the scar.

The Operation by Stretching the Sphincters (Fig. 1378).—This is not always followed by a permanent cure. When cure results it is probable that the diseased nerve fibers in the scar have been torn from their healthy connections.
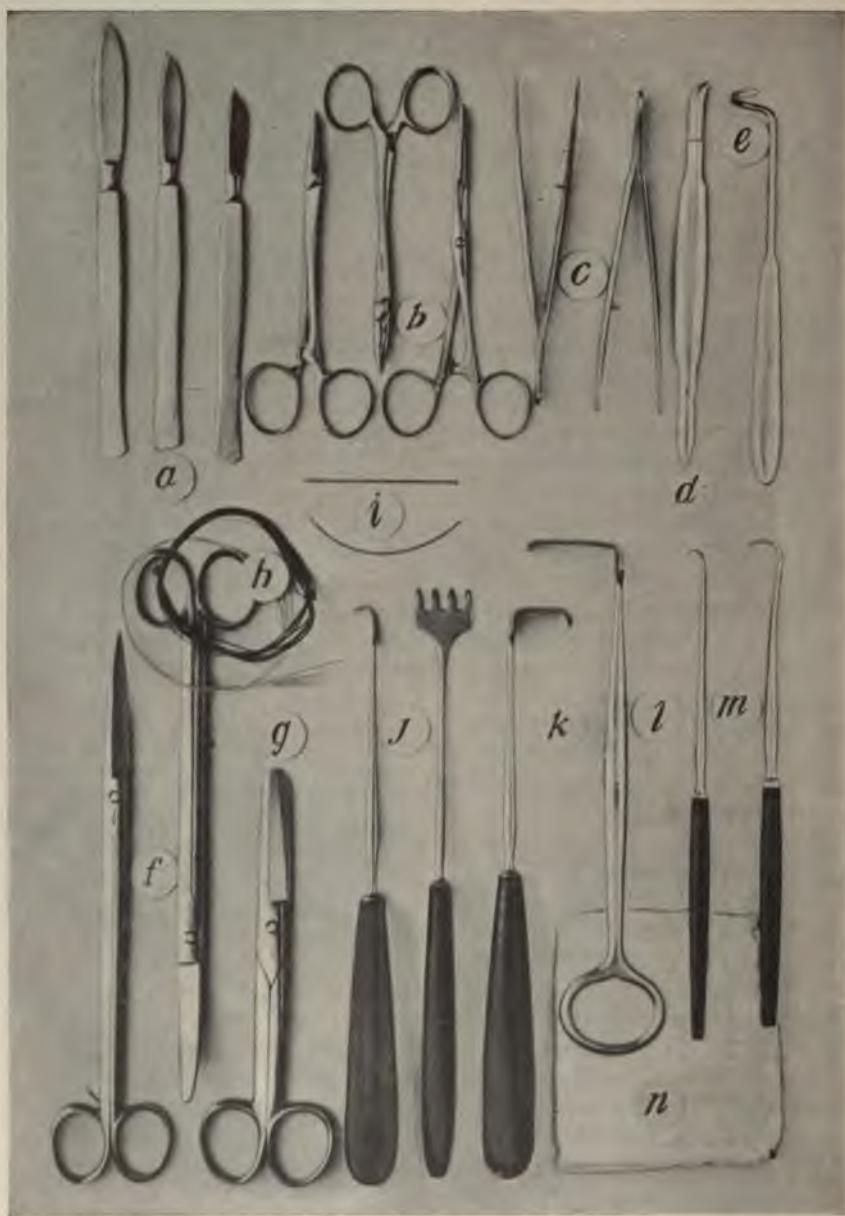
Fig. 1441.—Instruments employed in excision of the mammary gland.

a. Scalpels. *b.* Forcipressure. *c.* Dissecting and mouse-tooth forceps. *d.* Blunt dissector. *e.* Aneurism needle. *f.* Long blunt- and sharp-pointed scissors. *g.* Short blunt-pointed scissors. *h.* Catgut and silkworm gut. *i.* Long and curved needles. *j, k.* Blunt and hooked retractors. *l.* Tenaculum. *m.* Blunt hook. *n.* Wiper. Forcipressure, ligatures, sutures, and wipers in abundance are needed, and rubber drainage tubing should be at hand.

Kocher's Incision (Fig. 1442).—The outline of Kocher's incision is practically similar to Halsted's, but is placed in a reverse manner (Fig. 1448). The lower part of the incision corresponds to the axillary border of the pectoralis major and the upper extremity to a point just outside the middle of the clavicle. Through this portion of the incision the pectoralis major and minor are readily divided, the axilla freely exposed, and the vessels and nerves are disclosed up to the clavicle. The inner part of the incision is made so as to include the diseased gland and the proper amount of contiguous tissue. Kocher's incision is well suited for radical operations.

Senn's (E. J.) Incision.—After circumscribing the breast, as noted in the illustration (Fig. 1442) the incision is continued at the outer border of the pectoral muscle upward to a point an inch above the border of the axilla, thence in an outward curved manner terminating at a point corresponding
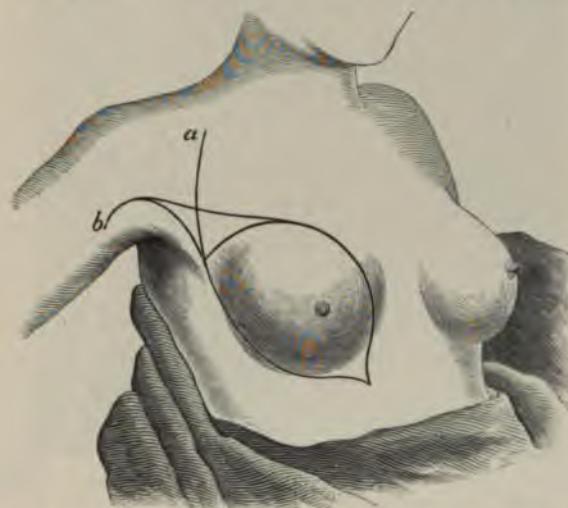
FIG. 1442.—The operation of excision of the breast. *a.* Line of Kocher's incision. *b.* Line of Senn's incision.

with the apex of the axilla. This incision permits free and early exposure of the vein, and removes from the axilla a line of union which is often irritated by perspiration, capillary growth, and imperfect asepsis, and also a scar that may cause subsequent annoyance. *Hartley; Keen, Weir,* the writer, and others have employed this modification for three years or more with satisfaction.

Warren's Method (Fig. 1443).—*Warren* makes a pear-shaped incision, which, with removal of the breast, he describes as follows:

"An incision is made from the anterior margin of the axilla along its anterior border, or slightly above, following the line of the pectoralis major muscle around the lower border of the breast to a point on the boundary line of the inner and lower quadrant. A second incision begins at the middle of the anterior axillary fold and gradually diverges from the first incision as it approaches the breast, when it sweeps around the upper border of the

organ to meet that incision again at its terminal point. The amount of
skin thus included is pear-shaped, the point being at the upper axillary
margin.   The direction of these incisions varies somewhat according to the
locality of the nodule; but a very large amount of tissue should be sur-
rounded by them, usually the whole breast, and occasionally a portion of
the adjacent integuments.   The edges of the wound should be reflected
back and the dissection made so as to expose the margin of the mammary
gland.   The knife is now carried down to the pectoralis major muscle,
which is freely exposed along the line of the whole upper incision.   The
sternal portion of the pectoralis major muscle is now separated from the
thorax, and the whole mass to be removed is thrown outward.   The muscle

Fig. 1443.—Excision of the breast.   Warren's lines of incision.   *a*. Incision to clav-
icle.   *b*. Incisions for secondary flaps.

is divided near its humeral insertion. This exposes freely the pectoralis
minor and the axilla.   Should the upper incision have been carried some
distance below the clavicle, a third incision (*a*) may now be made at right
angles to the first, so as to lay bare the axillary vessels up to the point
where they pass beneath the clavicle.   The pectoralis minor should now be
divided and its halves reflected or removed. The dissection of the axilla
follows next, the axillary vessels being carefully cleansed of all adipose
tissue from their point of emergence beneath the clavicle down to and
through the axilla.   Special attention should be paid to a prolongation
of adipose tissue, which lies in front of the vessels, and a similar tongue
of tissue which runs up behind them.   A thin, blade-like mass of adipose
tissue lying between the serratus magnus and the subscapularis should also
receive the attention of the surgeon, for here numerous shotlike glands
are found in the more malignant forms of the disease.   As the dissection
of the axilla proceeds the branches of the large vessels are cut and tied,
and also any thoracic or scapular nerves which interfere with a thorough

cleansing of the part are cut.   The contents of the axilla are now reflected outward, together with the mamma and pectoral muscles; a few long sweeps of the knife loosen the outer attachments of the mamma, and the whole infected area is separated from the body in one continuous mass.

" If there is any reason to suspect an infection of the supraclavicular glands, the vertical incision should be extended above the clavicle; the posterior cervical triangle can thus be exposed and its contents dissected.   Division of the clavicle does not add materially to the exposure of the region."

The secondary incisions at the side of the chest (b) are for the purpose of forming flaps with which to close the wound when approximation of the borders will not suffice and when skin grafting is not regarded with favor.   *For latest method and results, see Annals of Surgery, vol. xl, No. 6; also the Journal of A. M. A., July 15, 1905.*

Cheyne's Incisions, etc.   (Figs. 1444, 1445, and 1446).—It should be noted that these incisions include not only the skin covering the entire breast, but also a decided increase of the area at the aspect of the organ bearing the disease.   *Cheyne* does not carry the incision straight down to the muscle, but instead dissects up only sufficient of the underlying fat along with the skin to preserve the vitality of the latter, thus leaving behind and still connected with the tumor the outlying lobules of the breast and the lymphatics and vessels contained in the deeper fat which are connected with the growth, thereby excluding these elements of danger and render-

Fig. 1444.—Excision of the breast.   Cheyne's line of incision for removal with central involvement.

ing easier the final closure of the wound.   The pectoral fascia is invariably removed and at least a superficial layer of the great pectoral muscle, along with the diseased gland and the deep fat, preferably in a common mass. When diseased, the pectoral muscles are entirely removed.   The fasciæ connected with these muscles ought always to be removed.

Cheyne does not clear the posterior triangle of the neck unless he detects

enlargements there, or finds infected nodules in the fat lying behind the vessels extending into the triangle.

FIG. 1445.—Excision of the breast. Cheyne's line of incision for removal in involvement of the lower border.

The Methods of Operation.—The radical methods of practice and the so-called common method are recognized. The latter is superior in many respects to other non-radical methods of operative relief of a comparatively
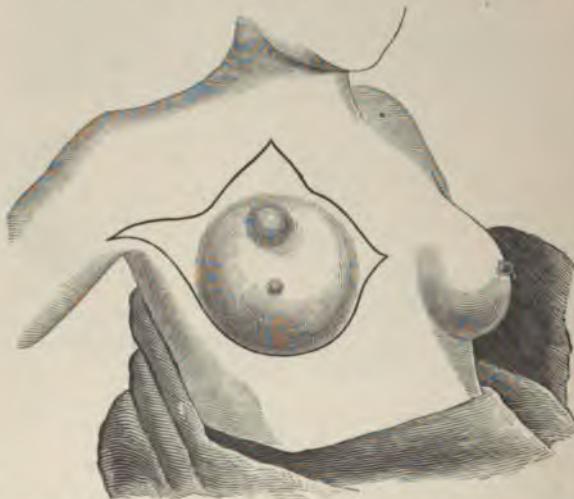
FIG. 1446.—Excision of the breast. Cheyne's line of incision for removal in involvement of the upper border.

recent date. The former methods are the outgrowth of patient study of operative results, based on a technique comprehending the wide removal of malignant manifestations, together with their prospective seats of occur-

rence when practicable. Warren's and Cheyne's methods are examples of this class.

The Position of the Patient.—Usually the patient is placed on the back, near to the edge of the table, the head and shoulders raised, and the arm extended from the side and retained in position by an assistant; an inci-

Fig. 1447.—Excision of the breast, Halsted's method. Tissues removed *en masse.*

sion is made, which is varied according to the plan of procedure adopted by the surgeon.

Halsted's Method (*Radical*).—The excellent results secured by Halsted require, it seems to us, that the technique as practiced by him be presented only in his own language. Halsted's method of practice is based on the proposition that the pectoralis major muscle, entire or all except its clavicular portion, should be excised in every case of cancer of the breast, because the operator is enabled thereby to remove in one piece all of the suspected tissues.

"The suspected tissues should be removed in one piece (Fig. 1447), (1) lest the wound become infected by the division of tissues invaded by the disease or of lymphatic vessels containing cancer cells, and (2) because shreds or pieces of cancerous tissue might readily be overlooked in a piece-meal extirpation.

"1. The skin incision is carried at once and everywhere through the fat (Fig. 1448).

"2. The triangular flap of skin, b, a, c, is reflected back to its base line, c, b. There is nothing but skin in this flap. The fat which lined it is dissected back to the lower edge of the pectoralis major muscle, where it is continuous with the fat of the axilla.

"3. The costal insertions of the pectoralis major muscle are severed, and the splitting of the muscle, usually between its clavicular and costal portions, is begun and continued to a point about opposite the scalenus tubercle on the first rib.
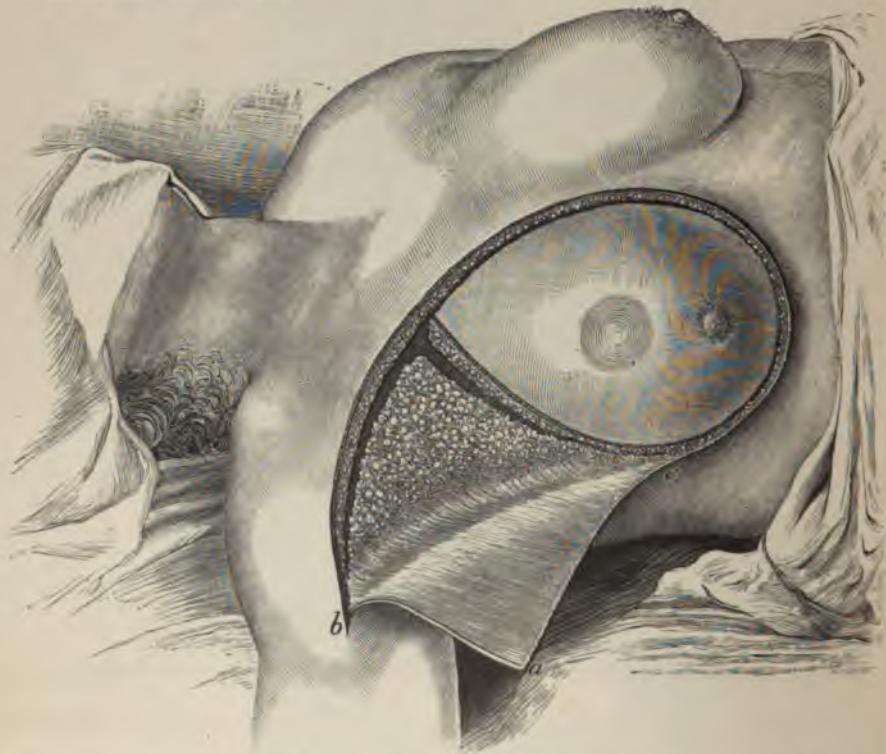
FIG. 1448.—Excision of the breast, Halsted's method. b, a, c. Triangular flap. b, c. Base line.

"4. At this point the clavicular portion of the pectoralis major muscle and the skin overlying it are cut through hard up to the clavicle. This cut exposes the apex of the axilla.

"5. The loose tissue under the clavicular portion (the portion usually

left behind) of the pectoralis major is carefully dissected from this muscle
as the latter is drawn upward by a broad, sharp retractor. This tissue
is rich in lymphatics, and is sometimes infiltrated with cancer (an
important fact).

"6. The splitting of the muscle is continued out to the humerus, and
the part of the muscle to be removed is now cut through close to its humeral
attachment.

"7. The whole mass—skin, breast, areolar tissue, and fat—circum-
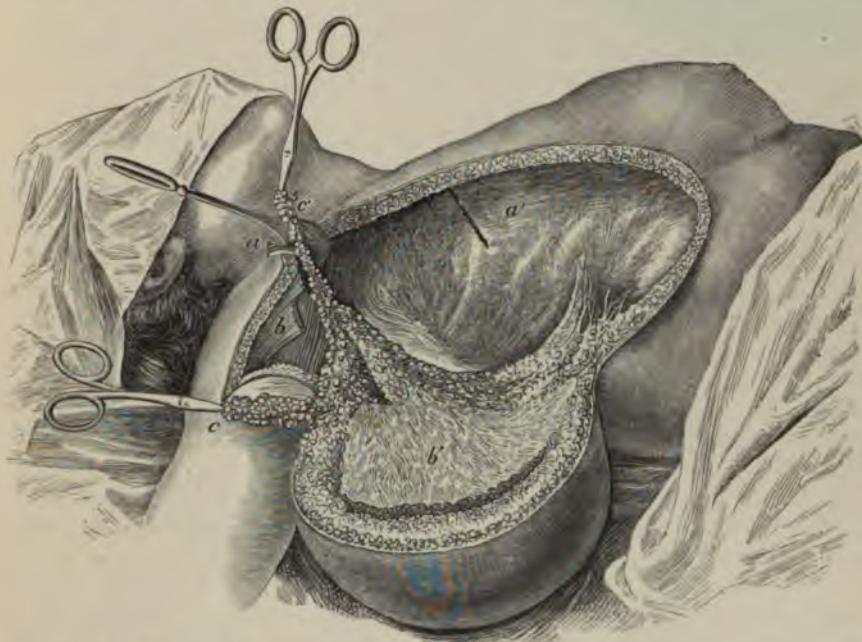
Fig. 1449.—Excision of the breast, Halsted's method. a. Reflected part of pectoralis
minor muscle. a'. Central part of pectoralis minor muscle. b. Humeral insertion
of sternal portion of pectoralis major. b'. Severed part of sternal portion of pec-
toralis major. c, c'. Fatty prolongations bearing lymph nodes.

scribed by the original skin incision is raised up with some force, to put the
submuscular fascia on the stretch as it is stripped from the thorax close to
the ribs and pectoralis minor muscle. It is well to include the delicate
sheath of the minor muscle when this is practicable (Fig. 1449).

"8. The lower outer border of the minor muscle having been passed
and clearly exposed, this muscle is divided at right angles to its fibers and
at a point a little below its middle.

"9. The tissue, more or less rich in lymphatics and often cancerous,
over the minor muscle, near its coracoid insertion, is divided as far out
as possible, and then reflected inward in order to liberate or prepare for
the reflection upward of this part of the minor muscle.

"10. The upper outer portion of the minor muscle is drawn upward
with a broad, sharp retractor (a). This liberates the retractor, which until

now has been holding back the clavicular portion of the pectoralis major muscle.

"11. The small blood-vessels (chiefly veins) under the minor muscle, near its insertion, must be separated from the muscle with the greatest care. These are imbedded in loose connective tissue which seems to be rich in lymphatics, and contains more or less fat. This fat is often infiltrated with cancer. These blood-vessels should be dissected out very clean and immediately ligated close to the axillary vein. The ligation of these very delicate vessels should not be postponed, for the clamps occluding them might of their own weight drop off or accidentally be pulled off, or the vessels themselves might be torn away by the clamps. Furthermore, the clamps—so many of them—if left on the veins would be in the way of the operator.

"12. Having exposed the subclavian vein at the highest possible subclavicular point, the contents of the axilla are dissected away with scrupulous care, also with the sharpest possible knife. The glands and fat should not be pulled out with the fingers, as advised, I am sorry to say, in modern text-books and as practiced very often by operators. The axillary vein should be stripped absolutely clean. Not a particle of extraneous tissue should be included in the ligatures which are applied to the branches, sometimes very minute, of the axillary vessels. In liberating the vein from the tissues to be removed, it is best to push the vein away from the tissues, rather than hold the vein and push the tissues away from it. It may not always be necessary to expose the artery, but I think that it is well to do this, for sometimes, not usually, the tissue above the large vessels is infiltrated, and we should not trust our eyes and fingers to decide this point. It is best to err on the safe side, and to remove in all cases the loose tissue above the vessels and about the axillary plexus of nerves.

"13. Having cleansed the vessels, we may proceed more rapidly to strip the axillary contents from the inner wall of the axilla—the lateral wall of the thorax. We must grasp the mass to be removed firmly with the left hand, and pull it outward and slightly upward with sufficient force to put on the stretch the delicate fascia which still binds it to the chest. This fascia is cut away close to the ribs and serratus magnus muscle.

"14. When we have reached the junction of the posterior and lateral walls of the axilla, or a little sooner, an assistant takes hold of the triangular flap of skin and draws it outward, to assist in spreading out the tissues which lie on the subscapularis, teres major, and latissimus dorsi muscles. The operator having taken a different hold of the tumor, cleans from within outward the posterior wall of the axilla. Proceeding in this way, we make easy and bloodless a part of the operation which used to be troublesome and bloody. The subscapular vessels become nicely exposed and caught before they are divided. The subscapular nerves may or may not be removed, at the discretion of the operator. *Küster* lays great stress upon the importance of these nerves for the subsequent usefulness of the arm. We have not as yet decided this point to our entire satisfaction, but I think that they may often be spared to the patient with safety.

"15. Having passed these nerves, the operator has only to turn the mass

back in its normal position, and to sever its connection with the body of the patient by a stroke of the knife from *b* to *c*, repeating the first cut through the skin.

"The edges of the wound are approximated by a buried purse-string suture of strong silk. Of the triangular flap of skin (*b, a, c*) only the base is included in this suture. The rest of this flap is used as a lining for the fornix of the axilla. The apex (*a*) of this flap is consequently shifted to a new and lower position. The axilla is never drained, and invariably heals by first intention. The uncovered wound often heals by the so-called organization of the blood clot."

Meyer's Method (*Radical*).—Meyer's plan of action, with which Halsted's is sometimes historically associated, while seeking the same ends as the latter, differs somewhat in the details, and, like it, is substantially quoted in full for the benefit of the operator.

The Operation.—" Make the primary incision as usual, embracing a liberal piece of skin around the nipple (Fig. 1450, *a, d*), which incision
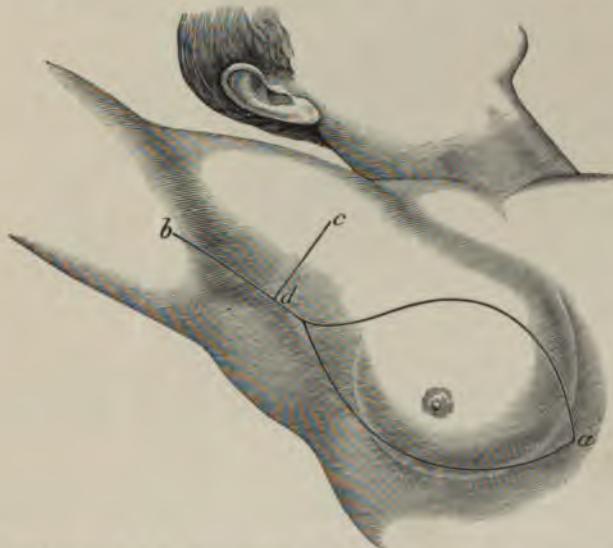
Fig. 1450.—Excision of the breast, Meyer's method. *a, d.* Primary incision around breast. *b.* Upper limit of incision. *c, d.* Vertical incision from junction of middle and center thirds of clavicle.

is at once run up into the axillary cavity, about an inch and a half to two inches farther than in the ordinary operation (*b*). This is done in order more easily to reach the tendon of the pectoralis major muscle on the humerus; make an additional skin incision from the clavicle at the junction of its middle and outer thirds downward, meeting the first wound at right angles (*c, d*); reflect the skin flaps, with as thin a layer of the underlying fat as possible, leaving just enough so as not to endanger a future necrosis of the flaps, exposing (Fig. 1451): 1. The insertion of the pectoralis major (*p*) muscle to the clavicle and sternum. 2. The insertion

of the same muscle to the humerus (*t*), the cephalic vein (*c, v*) in Mohrenheim's subclavicular space. 3. The border of the latissimus dorsi muscle (*l, d*); divide the pectoralis major muscle in its tendon close to the humerus (the raised arm of the patient must be somewhat lowered for this purpose), and separate the same to its insertion into the clavicle. Cut it off at once down to the sternal extremity of the bone, in order to thoroughly expose the contents of the axillary cavity and the infraclavicular and subclavicular region. During this time an assistant exerts some traction on the breast to put the tissues on the stretch; excise the subclavicular, infraclavicular, and axillary fat, glands, and lymphatics, with the knife, beginning over the bundle of nerves and vessels high up in the cavity, and continuing
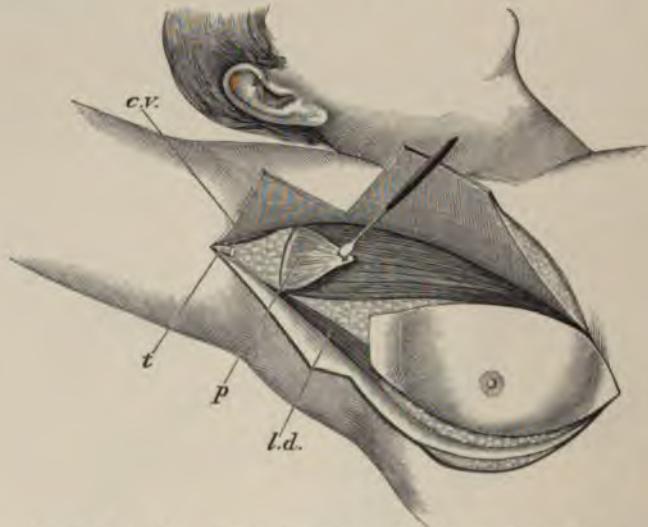
FIG. 1451.—Excision of the breast, Meyer's method. *p.* Pectoralis major muscle. *t.* Tendon of pectoralis major muscle. *c.v.* Cephalic vein in Mohrenheim's space. *l.d.* Latissimus dorsi muscle.

downward from the lower border of the subclavian and axillary veins. As soon as freed, these contents, having been divided on the outer side from the fat in the upper part of the sulcus bicipitalis of the arm, are raised and cut out from the outer side inward, beginning at the border of the latissimus dorsi muscle. This excision is continued, including the fat on the subscapularis and teres major muscles, until the chest walls—viz., ribs, intercostal, and part of the serratus magnus muscles—are plainly seen, and until the 'lower' surface of the pectoral muscles is reached. Fat with glands and lymphatics are nowhere cut into, but remain in one piece, and are attached to the outer lower border of the pectoral muscles in their normal anatomical relation. Divide the tendon of the pectoralis minor muscle at the coracoid process; cause the assistant to gently elevate the breast and muscles, in order to put the blood-vessels, which enter and leave the pectoralis major muscle, on the stretch. As mentioned above, these are clamped before they are divided. Amputate the pectoralis major

muscle at its attachment to the sternal extremity of the clavicle, and both muscles at their insertions to the ribs and sternum close to the bones. These portions form the pedicle of the whole mass, and when divided the extirpation of the cancer is complete. Suture the wound as far as possible, using plate sutures for the sake of better coaptation; drain the axillary cavity as usual. The large defect is always to be covered with rubber tissue in order to favor rapid healing under the moist blood clot."

The Precautions.—In order that no chance of cancer infection of a wound can happen during operation, infected glands and lymphatics should be removed without division when possible. And, if divided, they should be wrapped in gauze at once, and the wound freely douched to wash away the possible contamination. Healthy tissue should not be incised with a knife contaminated by contact with malignant tissue until after a thorough cleansing of the instrument. Free handling of a cancerous growth should not be succeeded by manual contact of fresh wound surfaces with unwashed hands. The removal of malignant extension should be done from outside of the diseased area, and not from within it, from motives of safety. Tearing and blunt dissection of the infected tissues should be avoided, and keen division with a sharp knife practiced for apparent reasons. The maintenance of the integrity of the clavicular portion of the pectoral muscle is usually feasible in thorough operative procedure, and is essential to the practical use of the arm in the absence of the sternal part of the muscles. A protracted fixation of the limb in one position, or the construction of a shallow axilla, contribute greatly to impeded movements of the extremity. Enlarged glands located within the area influenced by the growth should be sought for and removed along with contiguous connective tissues. The supraclavicular and infraclavicular spaces should not escape attention, and may be wisely divested of their lymphatic structures in many cases, irrespective of the presence of evidences of infection.

The Remarks.—Mammary cancers of the smallest size may have caused already lymphatic and muscular infection. Axillary lymphatic glands may have become infected without the occurrence of appreciable enlargement therefrom. In malignant involvement of the fascia covering the pectoral muscle the muscle itself may be free from the disease, as the lymphatic systems of these structures do not communicate freely in the majority of instances. However, the effect of non-muscular involvement should not be assumed; it should be a matter of established surety.

" A tumor, however freely movable on the underlying parts, has almost certainly advanced as far as the surface of the muscle " (Heidenhain). " The efficiency of an operation is measured truer in terms of local recurrence than of ultimate cure " (Halsted). Any deficiency in the integumentary flap that may follow a special plan of treatment, or of a wide removal of the disease, can be repaired at once, or later by Thiersch's method of skin grafting.

The recognized inability to remove entirely the disease contraindicates any method of attempt, unless it be done to improve the morale of the patient or to secure euthanasia. If a breast be affected with malignant disease, the entire organ should be removed at once.

83

It is important to note that the margin of the normal breast extends much beyond the limits determined by palpation—a fact especially noticeable in the removal of virgin breasts and those freely clad with adipose tissue. The tissues contiguous to the axillary vein and those at the inner aspect of the apex of the axilla are the most frequent seats of malignant infection, and next in order is the fatty tissue behind the vessels, thence upward to the posterior portion of the subclavian triangle. The condition of the glands lying between the pectoral muscles and those associated with the vein as it lies contiguous to the first rib, especially the latter, are a fair index of the condition of those beyond. In 1880 *Gross* expressed the opinion that supraclavicular lymph nodes were infected in 6.25 per cent of the instances of axillary node involvement. *Halsted* has demonstrated by microscopical examination of the tissues removed from this space that infection is present in the lymph nodes in 34 per cent of the instances.

The operative technique of the less radical methods of procedure is fairly represented in the following statement:

The Operation.—Make an elliptical incision through the skin and fascia from a point opposite the center of the axilla (Fig. 1452) downward
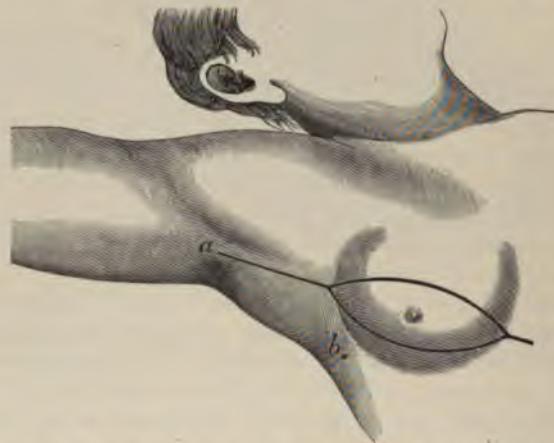
FIG. 1452.—Excision of the breast, so-called conservative method. *a.* Lines of primary incision. *b.* Drainage opening.

parallel with the anterior fold, ending just beyond the mamma, of sufficient width to provide an ample amount of sound integument at either side of the morbid growth; divide the tissues beneath the upper incision down to the pectoral muscle, while the assistant draws upward the integument and the operator presses downward the breast, so that it is forced well out of the way; turn the breast downward and expose the pectoral muscle by blunt and sharp dissection, closing the bleeding points by forcipressure; place between the separated structures an aseptic towel; divide the tissues beneath the lower incision as carefully as were those of the upper, while converse force is being exercised; raise the growth and sever the remaining inferior connections, catching the bleeding points as they appear; dissect

away the overlying pectoral fascia and such portions of the muscle as are diseased; introduce the finger through the upper end of the incision into
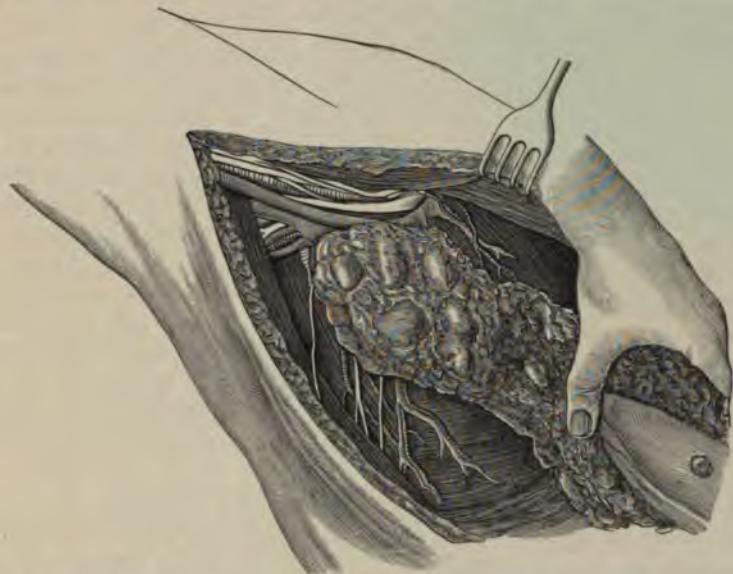
Fig. 1453.—Excision of the breast, so-called conservative method. Removal of diseased mass.

the axilla, and search for enlarged glands, especially along the course of the anterior axillary chain of lymphatics; expose at the upper end of the incision the axillary vein; raise upward the pectoral muscle, and remove by blunt dissection inward and downward with the finger the diseased glands and contiguous connective tissue, removing if practicable the entire mass at once (Fig. 1453); tie the bleeding points with catgut; establish drainage

Fig. 1454.—Excision of the breast, so-called conservative method. Drainage openings indicated.

openings at the dependent parts; irrigate the wound with an antiseptic solution; dry it carefully with gauze pressure; introduce the sutures first at the upper and lower ends of the wound (Fig. 1454); later introduce the drainage tube and the sutures of the middle part of the wound by means of a short free incision or puncture; adjust the borders of the wound carefully, and tie the sutures throughout, following up the line of tying with continuous sponge pressure; remove the sponges in the order of application, and dust the line of union with iodoform, covering it with a broad strip of iodoform gauze; reapply for pressure purposes along the line of the wound fresh sponges, or elastic gauze dressing instead; carry the arm across the chest at about a right angle, keeping the elbow at the side, or place the hand on the opposite shoulder, carefully introducing beneath the limb for the entire length sufficient dressing to obliterate completely the wound, and comfortably pad the parts without constriction of the circulation; raise the patient into the sitting posture, if practicable, and bandage the arm to the body, carefully noting the influence of the bandaging on the radial pulsations; secure the bandage in place with numerous safety pins, return the patient to bed, and leave in as comfortable a position as practicable.

The confinement of the arm at a right angle with the chest after operation for cancer of the breast, to avoid the immobility that often follows confinement at the side, is approved by Cheyne. *Dowd* has devised a jacket to support the dressings, without confinement of the extremity, which he regards with great favor.

The Precautions.—The removal of apparently diseased tissue from within the area of surgical scope in the conservative method of practice should be thoroughly done, and prospective sites of malignancy removed in the more radical methods of action.

The General Remarks.—The security of the axillary vein and the promptness of surgical dispatch in the removal of diseased structures from the axilla are sometimes greatly facilitated by primary exposure of the vein at the outer limit, followed by dissection and separation inward along the vessels to the center of the axilla.

The lower incision may be made first, thus avoiding the annoyance and obscuration caused by the flow of blood from a primary upper incision. If the axillary vein be involved, the diseased portion should be removed between two ligatures. The subscapular vein often requires tying—a fact of no special significance. Proper observation and complete and safe removal of the diseased nodes at the apex of the axilla require division of the pectoral muscles, which may be thereafter removed or repaired by sewing, as circumstances demand.

A free incision made in the long axis of the clavicle, or the turning upward of a flap limited by the posterior border of the sterno-mastoid muscle of sufficient size to expose the glands in the supraclavicular space, can be employed. The latter is better calculated to meet the full requirements of the procedure.

When practicable, the skin incision for removal of the breast may be so planned as to secure proper apposition of the margins of the wound.

The influence of traction sutures, inserted far away from the margin of the wound and tied, is of decided importance in securing coaptation of the borders in instances of scant integumentary flaps.

Treves advises that the arm be abducted and the hand placed behind the head, and held there by the anæsthetist during the operation. The axilla should be shaven closely, so as to avoid as much as possible the irritation incident to growing hairs during recovery. All bleeding points should be tied with fine strong catgut, to avoid the oozing that may follow a less secure means of closure. In stout patients the detection and secure ligaturing of every oozing point is especially important, since in such cases the bleeding points are often hidden in the fat and escape notice, only to ooze thereafter in a most perplexing manner. The wound should be cleansed by douching, and dried by compression with gauze or sponges, and not wiped by either. Careful obliteration of the entire wound by gauze or sponge pressure should be secured, to avoid the presence of dead spaces. A return of the disease in the line of operative procedure can not be disregarded, as it strongly emphasizes the facts of incomplete removal and defective technique.

Amputation at the extremity for removal of cancerous disease of the axilla can not be commended as a means of cure. In cases amenable to this plan the disease has no doubt extended so far beyond the axilla as to forbid the amputation with the expectation of final relief. However, in instances where excessive pain from brachial plexus involvement torments the patient, the expediency of amputation may then be entertained for the purposes of euthanasia.

The after-treatment consists largely in attending to the comfort of the patient. The wound should be redressed on the third day and the drainage agent removed if employed, unless soiling of the dressings or unexpected happenings call for prompter action. Thereafter the dressing is not changed for five or six days, and perhaps longer in many cases. The sutures are removed in a week or ten days, and the arm is liberated at about the same time. The patient is ordered out of bed during the second week usually, and should be around a few days later. Early movement of the limb is advisable, to remedy as promptly as possible any restricted motion that may ensue. A careful scrutiny of the patient should be practiced at intervals of six or eight weeks for a long time, to detect the earliest manifestations of a recurrence. Prompt, wide, and repeated removal should follow successive manifestations, when practicable.

The Results.—The death rate (about 2 per cent) from the operation alone, when performed with aseptic care, according to any established method, does not contraindicate the measure in operable cases. Inasmuch as the deltoid and coraco-brachialis muscles assist the pectoral muscle in drawing the arm forward and inward, the removal of the greater portion of the latter, while not lessening materially the range of movements of the arm, does diminish decidedly the power of these movements. Other things being equal, the frequency of the recurrence and the brevity of the period of local return are the proper measures of the value of an operation for the eradication of malignant disease. In 1889 *Williams*, from the experience of

the Middlesex Hospital, stated, according to Treves, that "the average duration of life, dating from the time the disease was first noticed, is 60.8 months for those who undergo operation, and 44.8 months for those in whom the disease runs its natural course. The average duration of life subsequent to amputation of the breast is 40.3 months. The average interval between the first operation and the first recurrence is 26 months; the maximum, 130 months; the minimum, 2.5 months." *Warren's* experience places the mortality rate at 2 per cent, and 40 per cent as alive and well at the end of three years. Cheyne reports that in 99 unselected cases 56 were free from disease from one to nine years, also that in 61 of the 99, 30 were free from recurrence at the end of three years.

In 1894 *Halsted* published the outcome of fifty cases operated on by himself since June, 1889, and estimated along the same lines of consideration as those of similar reports published elsewhere, especially by eminent German surgeons. The results attracted marked attention on account of the comparatively high degree of success which they exhibited, and the direct relation that it seemed to bear to the logic of extensive and thorough operative technique. However, since many of the cases had not then reached the three-year limit of cure, an announcement of the final result was awaited with deep interest by thoughtful surgeons. *Halsted* has recently announced that over 52 per cent of his patients have lived more than three years after operation without local return or metastasis.

The general average of trustworthy reports based on the three-year limit show a rate of cure of about 40 per cent.

Only the results of the general average of stated methods of operation are considered, because the announcement too often made of improved results in a limited number of cases without definite expression as to the technique employed should be regarded as being a matter of a greater personal bearing than of scientific importance.

The Choice of Operation.—We employ the radical method whenever practicable, and, in our opinion, little remains to be said regarding this matter from the standpoint of surgical expediency. The average standard of attainment of the older and less radical methods appears to have reached already its highest altitude. The advent of the newer, a radical and more logical plan of action, with a much greater percentage of achievement, and without proportional danger, begets renewed hope, which should be sustained by like surgical endeavor until the true value of the measure is established. A radical operation is indicated in all cases in which general infection has not occurred, and local manifestations, together with the prospective sites of malignant advance, admit of complete removal without immediately exposing to unusual danger the life of the patient.

Non-malignant Tumors.—In the removal of non-malignant tumors from the breast the incisions should be so formed as to cause the least possible final disfigurement or interference with the function of the organ. The nipple is the most essential feature, and should be preserved when possible.

The pectoral border of the axillary fold can be pulled toward the median line of the body, and the breast removed through an incision corresponding

with the direction of the fold, and the return of the tissues to the natural site will hide the cicatrix and present an undisfigured surface to view.

Thomas's Method. — *Thomas* carried around the lower margin of the breast in the line of the mammary fold an incision of sufficient length and depth to permit the easy turning upward of the organ (Fig. 1455). The diseased portion of the gland was then removed from beneath without involvement of the integument above, the breast returned to the normal position, and the divided borders were united with sutures. In these instances the nipple can usually be saved, and recovery takes place with a minimum degree of scarring. We have practiced this method in several instances with entire success.

FIG. 1455.—Excision of the mammary gland. Thomas's method.

Thoracentesis. — The tapping of the pleural cavity for the relief of pleural effusions especially and of hydrothorax is a common procedure (Figs. 1280 and 1281). The aspirator with the trocar and cannula attachment is better than the needle alone, as the latter may inflict injury on the lung tissue, especially during the withdrawal of the fluid (Fig. 1456).

The Anatomical Points.—The intercostal vessels and nerves run along the contiguous borders of the ribs, sheltered somewhat, especially at the posterior halves, by the grooved arrangement of their lower borders. The attachments to the walls of the thorax, of the diaphragm, and the influence on its relations to the thoracic contents of the respiratory acts, are often important in this operation, and therefore the consulting of a standard work on anatomy in this regard may not be amiss. The intercostal spaces, especially at the accepted points of puncture, are easily and safely penetrated.

The Operation.—The sixth intercostal space in the midaxillary and the eighth in the scapular lines are the sites usually selected for the puncture. Place the patient on the back with the afflicted side at the edge of the bed; raise the arm out of the way; cleanse the part thoroughly and draw the skin

FIG. 1456.—Thoracentesis. Fitch's aspirator. *a.* Trocar. *g.* Cannula. *c, c.* Couplings. *e.* Rubber tube. *f, f.* Glass tube sections.

upward at the seat of attack and hold it with the thumb and fingers; cocainize the part and then puncture the skin near to the upper edge of the lower rib of the chosen space with a narrow knife; thrust into the punc-

ture the trocar or needle inward and upward through the pleura limiting
the extent of penetration by the finger; draw off the fluid slowly, regulating
the flow by the symptoms of the patient. If blood appear, withdraw the
needle at once. The wound is closed and sealed with collodion.

The Precautions.—Before tapping is performed, the nature of the fluid
and the proper seat of the puncture should be determined by the agency of
a hypodermic syringe. In tapping be sure to enter the chest cavity and to
avoid at the same time the lung. With a limited collection of fluid the
latter may be easily injured, unless wise forethought be exercised. The
fluid should be withdrawn slowly, as rapid escape may cause syncope,
œdema of the lung, and other disagreeable and perhaps dangerous mani-
festations. The withdrawal should cease in such instances and not be re-
sumed until after suitable restoration is established. The integument
should be *drawn upward* at the seat of proposed puncture to a degree pro-
portionate to the distention of the chest by the fluid, in order that the skin
puncture may conform to that of the wall after the latter is lowered follow-
ing relief from the distention. Especially is this important in the instance
of empyema when permanent and well-directed drainage is needed. The
point of the needle will impinge on the rib unless care be exercised, especially
if the intercostal space be narrowed. The lower the seat of puncture the
greater should be the upward direction of the needle to avoid the dia-
phragm. If the tube becomes blocked, reverse the current or remove the
obstruction with a stylet. If, before insertion, the needle be passed
through a thin piece of firm rubber, the rubber will be pushed along the
needle by the insertion, and accurately mark the distance to the pus, on
withdrawal of the puncturing agent.

The Remarks.—A general anæsthetic is rarely admissible. The sud-
den appearance of blood in the fluid may depend either on rupture of the
vascular adhesions, perhaps wound of the lung and possibly of a vessel of
the thoracic wall. Violent cough not infrequently attends the flow, due to
unfolding of the compressed lung, and during the attack the end of the
instrument should be directed as far as possible away from the lung. The
puncturing agent should be of sufficient size to permit the free escape of the
fluid, and even then the lodgment of the end in a caseous mass may mislead
the operators, unless the obstruction be pushed aside or its presence deter-
mined by a probe carried through the lumen of the instrument.

The evacuation of pus by this method of practice can not be regarded as
curative in chronic and tubercular cases, and at best should be employed
only as a temporary expedient to meet urgent demands. The very young,
and those much enfeebled, and in whom rapid and large collections of pus
are present, may be more satisfactorily and safely treated by a preliminary
operation of this character.

The Results.—In acute cases in children with pneumonia, about 20 per
cent are cured (Holt).

Thoracotomy.—The operation of thoracotomy is usually limited to the
removal of a portion of one or two ribs, for the purpose of evacuating the
pleural cavity of pus or blood, and for the removal of diseased processes of
the chest wall and lung (Fig. 1458).

Paquelin's Cautery.
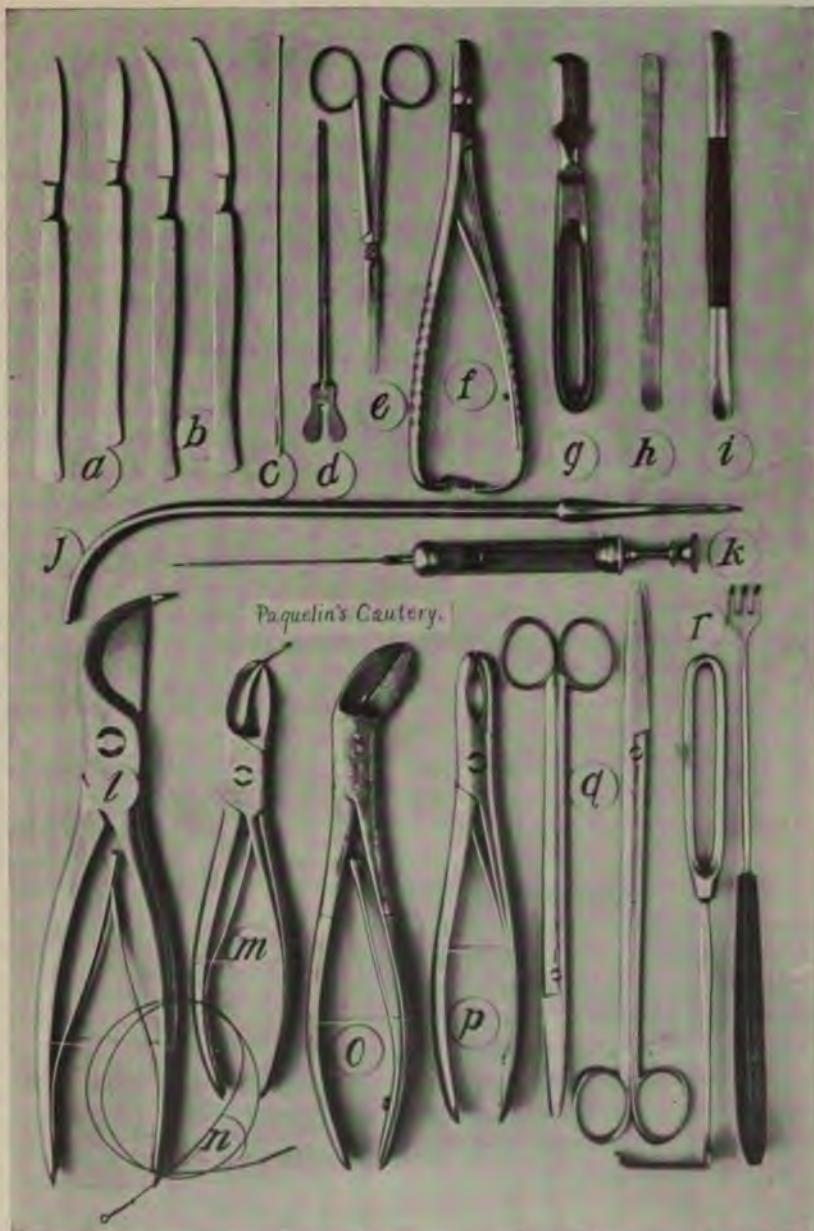
FIG. 1457.—Instruments employed in operations on the chest wall and the pericardium.

a. Large and small scalpels. b. Probe and blunt-pointed bistouries. c. Silver probe.
d. Grooved director. e. Sinus forceps. f. Needle holder. g. Rugine. h. Spatula
i. Periosteal elevator. j. Steel sound. k. Aspirating syringe. l. St. John's cos-
totome. m. Beck's costotome. n. Gigli-Haertel saw. o. Angular bone-cutting for-
ceps. p. Rongeur. q. Long blunt scissors, straight, and curved on the flat. r.
Blunt and hooked retractors. Forcipressure, thumb and mouse-toothed forceps,
ligatures, suturing needles, drainage tubes, wipers, etc., are required. An electric
light may be needed.

The Excision of a Portion of a Rib for Empyema.—It seems proper to note in this connection that collections of pus in the pleural cavity are frequently localized, and even multiple collections sometimes are present. This plan of action is especially valuable in cases with foul discharge and in those of a chronic nature with and without contraction of the chest wall.
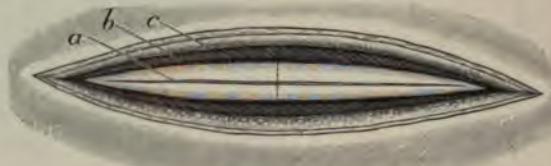
FIG. 1458.—The operation of thoracotomy, removal of segment of rib. *a.* Incision through periosteum of rib. *b.* Intercostal muscle. *c.* Superficial tissues, dotted line indicates transverse incision of periosteum.

The operation is, however, severer than that of simple incision, and therefore in the feeble and very young it should be selected with discretion.

The Operation.—After proper stimulation and thorough antiseptic precautions, place the patient on the back with the affected side at the edge of the table; employ local or general anæsthesia, as the condition of the patient requires; select the sixth or seventh rib; make an incision in a line of the axilla about two or three inches in length down upon the middle of the rib (Fig. 1458) in the long axis, through the periosteum; bisect the primary incision at the center with a transverse one the width of the rib; raise from the bone on both surfaces (Fig. 1459) with a periosteotome the peri-

FIG. 1459.—The operation of thoracotomy, removing periosteum from rib. *a.* Integument and subcutaneous tissues. *b.* Intercostal muscles. *c.* Periosteum. *d.* The rib. *e.* Periosteotome. *f.* Forceps.

osteum together with its surrounding tissues, being careful not to open into the pleural cavity; exsect an inch or an inch and a half of the bone, dividing it with a Gigli-Haertel saw (Fig. 1457, *n*) or rib forceps; arrest hæmorrhage and then make a suitable opening through the intervening structures into the pleural cavity (Fig. 1460), and permit the fluid to escape without special interference.

The Precautions.—Avoid division of the intercostal vessels, for obvious reasons. Irrigation is dangerous and ought not to be practiced except cautiously, and then only for the relief of foul discharges. The use of peroxide of hydrogen should be avoided in every instance; normal saline and boric-

acid solutions are the best for the purpose. Submersion of the patient in a warm saline bath affords an easy, comforting, and effective method of washing out the cavity. The precautions of thoracentesis for hydrothorax are pertinent in this procedure. If the opening be made too low, the ascent of the diaphragm will obstruct and possibly may close it. If too high the angle of the scapula will obstruct the opening. The lymph masses may be loosened by introduction of the finger or a sound, and removed with forceps whenever they obstruct the opening. The drainage tube should be incompressible, should just reach the pleural cavity, and be fastened so that it can not escape within. Sometimes two are employed (Fig. 1461) side by side, especially when washing of the cavity is practiced during healing, the fluid entering one and escaping by the other. If the tube happens

FIG. 1460.—Opening into the pleural cavity. *a*. Divided end of rib. *b*. The pleura. *c*. Periosteum. *d*. Muscular tissue. *e*. Integument and subcutaneous tissues.

to rest upon an intercostal nerve severe pain, referable to the distribution of the nerve, often occurs. The fluid should be permitted to escape slowly and ought to be temporarily arrested in case of severe coughing. If hæmorrhage happen into the pleural cavity, the tube should be introduced, the wound dressed, and the patient placed on the diseased side at once.

The Remarks.—It is wise that a bacteriological examination of the pus be made, to determine, as far as possible, the nature of the process. The drainage tubes should not be so long as to impinge on the lung, and ought to be shortened as the cavity contracts.

The After-treatment.—Antiseptic dressing should be applied liberally to

FIG. 1461.—Drainage of cavity with two rubber tubes. Soft parts sutured.

the seat of the operation, and changed frequently to avoid infection. The patient should be kept quiet, and indications of treatment met as they arise.

A sinus formation may be irrigated and generally treated as in other parts of the body. Gymnastic exercise and efforts directed to the prevention of contraction of the chest should be practiced.

If for removal of diseased bone, make an incision at the middle of the long axis of the rib (Fig. 1458) of sufficient length to include the diseased portion. Supplement this one at the center by a transverse incision. Separate the periosteum along with the superimposed tissues, liberate the bone, and raise it from its bed. If the sequestrum be not loose, time should be allowed for its separation. Two contiguous portions can be easily removed (Fig. 1278).

Simple Incision. — Simple incision with drainage is not now regarded with the same favor as formerly. The narrowness of the opening and its tendency to close and hinder drainage are serious objections in chronic cases, and, moreover, the opportunity for escape of the fibrinous products from the chest and the ability to properly remove them present objectionable features to the use of the method. But in limited collections of pus of an acute nature, and chronic cases in feeble patients, this method, if failing to cure, may often serve an important preliminary purpose. The establishment of the proper seat of the operation and the precautions attending the procedure differ in no essential respect from those of aspiration and of excision of a rib. The incision is made midway between the contiguous borders of the ribs, either in the axillary or subscapular line, as best suits the purpose, always remembering (as in the other operations) to avoid locating it so that the movements of the scapula or diaphragm can interfere with drainage. The incision is cautiously made down upon the pus, instead of entering the collection at once by a sudden thrust. The latter plan is unnecessary and needlessly dangerous. After the escape of the fluid and of the lymph products, drainage is established as in the preceding operations. However, the strong inclination of the opening to close because of the approximation of the ribs requires that the drainage agent shall not infrequently have rigid walls. To meet this indication we have in several instances utilized for the purpose the ordinary large-sized gutta-percha (Fig. 864, *l*, vol. i) tracheotomy tube, properly shortened, through which a rubber tube is carried. If the former be heated over an alcohol lamp, it can be cut off or bent in a direction to suit the demands of drainage and of protection to the lung at the same time. The collar of the tube fits closely to the side of the chest and can be held in place by means of an elastic tape fastened around the body. The removal from the upper border of the contiguous lower rib with a rongeur of a limited portion of bone sufficient to afford lodgment of the hard- or of a soft-rubber tube prevents pressure, and also obviates the closure of the latter.

The Remarks.—One opening is sufficient, and this need not be made at the most dependent part of the collection, as the lung expansion and diaphragmatic ascent expel the pus. The tube should be of fresh rubber at all times and be securely anchored with a safety pin. It should not reach within half an inch or so of the bottom wall of the abscess cavity, and the rapidity of the contraction, as ascertained by the introduction of water, should regulate the frequency and amount of the shortening of the tube.

The tube should be removed when only a small amount of sero-purulent fluid escapes.

The Results.—Incision and drainage, and primary excision give different results. The former a death rate of about 33, the latter about 20 per cent. In 467 cases treated by one of either methods, the average mortality was 26 per cent. The following tabulated statement of 123 cases of empyema in childhood is very instructive:

Results of Operations of Empyema in Childhood.   (*Brothers.*)

	No. of cases.	Recoveries.	Deaths.
Simple aspiration	9	2	7
Simple incision with drainage	98	64	14
The same after unsuccessful aspiration.....	9	8	1
Primary exsection...........................	2	2	0
Secondary exsection.	5	5	0
	123	81	22

Aspiration combined with Drainage.—Much has been said in the past of aspiration for the purpose of expansion of the lung and drainage in empyema. Potain, Perthes, Bülau, and others devised methods of relief, most of which were impracticable because they were too confining and cumbersome. The writer during the last year devised and applied successfully to the chest of a patient suffering from an extensive traumatic empyema * the following simple and effective apparatus (Fig. 1462): the end of the tube projecting beneath the cushion (*a*) is passed into the empyemic cavity a proper distance, and the cushion (*a*) is placed in contact with the wall of the thorax in such a manner as to command equally the area surrounding the opening into the pleural cavity. The nozzle of an ordinary six-ounce rubber syringe is then inserted into the distal end of the tube (Fig. 1463), the liquid withdrawn, followed finally by sufficient exhaustion of the air to cause the rubber cushion to fit closely enough to the chest wall to prevent the passage of air beneath it into the pleural cavity. The stopcock is then closed (Fig. 1464), the syringe removed, and the nozzle of the rubber bag

Fig. 1462.—The author's aspiration apparatus. *a.* Hollow rubber cushion. *b.* Distended rubber bag. *c.* Stopcock. *d.* Glass observation tube.

* From the Jacobi Festschrift.

(Fig. 1462, b) while fully collapsed is inserted firmly into the open end of
the tube (Fig. 1465), the stopcock reversed, thus establishing aspiration,
which is maintained so long as the bag is expanding. The chest is then
dressed and the apparatus duly fastened in place as indicated in Fig. 1466.
The patient can go about comfortably with the apparatus in action without
attracting special attention. When the bag is nearly distended, the stop-
cock should be closed, the bag cleansed, again collapsed, reapplied, and the
stopcock opened.

The Precautions.—If brisk and forcible aspiration by the syringe be
made, the tube will collapse (Fig. 1463), and often the discharge will be
tinged with blood, which can be noted through the glass segment of the
tube. Continuous and mild aspiration is safer and quite as effective as the
vigorous in the majority of instances. The degree of distention of the bag
should be frequently observed in order that it may be removed, cleansed,

FIG. 1463.—Aspiration of the cavity. *a.* The glass observation tube, showing suction
force applied by syringe.

and reapplied without the interruption of aspiration. Adhesive plaster
applied to the chest around the opening aids in the exclusion of air. Ab-
sorbent cotton thoroughly wet with a boric-acid solution or rubber tissue
hinders the passage of air beneath the cushion. It is very important in this
connection to remember that the cotton, or any small movable body, may
be drawn into the chest unless care be exercised. Should this happen it can
be removed quite readily in most instances by moving around in the cavity
the inner end of the tube while making suction on the outer with the
syringe.

In the cases to which aspiration has been applied it acted efficiently and
promptly, and was easily managed by the patient.

The Comments.—It seems to the writer that practicable aspiration offers
the opportunity of prompter cure in excision cases, and not impossibly may
render needless the more serious methods of practice by obviating the condi-
tions that prompt their use. Much contention has arisen in the past regard-
ing its feasibility. The writer notes with regret the seemingly strenuous

tenor of these contentions. Cases complicated with gangrene of the lung and abundant fibrinous deposits are certainly unsuited for the immediate
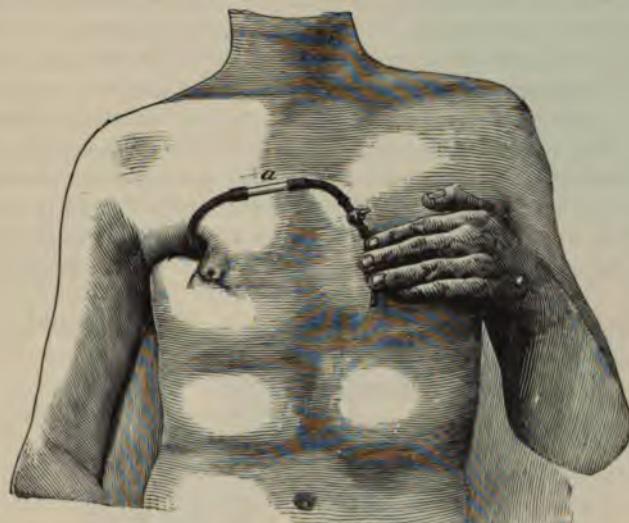
FIG. 1464.—Aspiration of the cavity. *a.* Segment of glass tube. Cavity aspirated and stopcock closed to prevent admission of air.

use of aspiration treatment. Repeated experience with the simple portable apparatus devised by the author since the writing of the preceding clause has not in any degree lessened his belief in its efficiency in suitable cases. On the contrary, the rapidity with which in nearly every instance the size
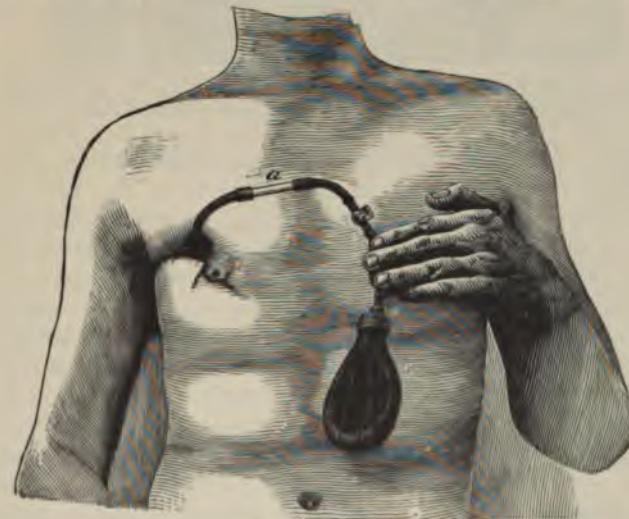
FIG. 1465.—Aspiration of cavity. The collapsed rubber bag attached and stopcock opened. *a.* Glass observation tube; the apparatus in action.

of an empyemic cavity has been reduced by this simple method of aspiration emphasizes its worth in limiting the often tedious course of this affection in a most decided manner. Now we, in nearly every instance, introduce the tube into the cavity as soon after resection of simple incision as will permit of the tissues being sufficiently tightly drawn around it with adhesive strips to prevent the entrance of air from without. Sometimes over these adhesive strips, aseptic absorbent cotton, wet with a boric-acid solution, is packed and confined in place with adhesive strips, before air can be excluded, when suction is applied. In such cases care must be taken to prevent air from forcing fragments of cotton into the cavity. The apparatus has proven decidedly efficient in those cases from which fibrin had been removed or in which not enough was present to obstruct the tube. Also in which the walls of a
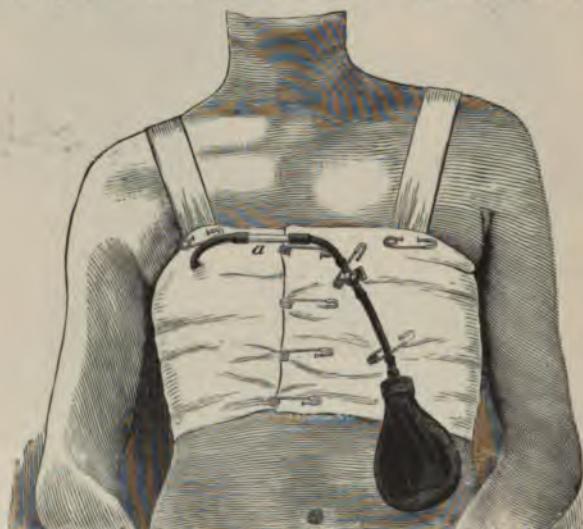
FIG. 1466.—Aspiration of cavity. *a.* Glass observation tube. The dressings applied; apparatus held in place by safety pins while in action.

small cavity or of a sinus were not obstructed from suction. The hollow rubber cushion (Fig. 1462, *a*) is not so secure as the use of adhesive strips. In many instances a glass chamber has been substituted for the glass tube (*a*), and the fluids collected therein as they were withdrawn by the rubber bag. In two instances the tube was inserted through a cannula deposited between the ribs by means of a fitting trocar, the cannula being removed as soon as the tube was in place. In those cases the tissues pinched the tube closely, especially when suction was applied, and easily excluded the admission of air. The influence of the force of aspiration on the dimension of a cavity is best appreciated by occasional measurement through the agency of water, introduced into it with the body always in the same posture. Both aseptic and antiseptic flushing are employed when indicated.

By the apparatus one can determine the presence of minute lung perforation; as then a vacuum can not be maintained.

Hutton has devised an ingenious and serviceable apparatus which per-

mits the escape of fluid from and prevents the entrance of air into the pleural cavity during the acts of breathing, coughing, etc. The apparatus consists of a large rubber drainage tube with a flange of sheet rubber five inches long and four inches broad; the tube passes through the middle of the flange. A valve of duckbill form is made by slitting a gutta-percha nipple at the end. The unslit portion of the nipple is connected by means of a glass tube with a short piece of rubber tube, which latter is finally connected with the main tube by means of a right-angled glass one. After the chest is opened the remaining end of the primary tube is cut off near enough to the flange to permit it to extend only through the chest wall. The apparatus is then bound firmly in place, the flange resting upon a large piece of wet gutta-percha tissue to prevent the entrance of air beneath. Hutton speaks in high terms of this device.

Thoracoplasty.—*Estländer's Operation.*—The operative practice associated with the name of Estländer is applicable to the long-standing cases of empyema, in which the powers of a natural cure are inadequate for the purpose, and draining by incision, or the excision of a limited portion of one or more ribs, has failed to afford relief. The size and extent of the abnormal cavity should be estimated with the finger or probe, or by the means of fluid injection. An incision made along the center of an intercostal space affords opportunity for removal of two contiguous ribs; two corresponding incisions, the removal of four ribs, etc. (Estländer). The soft parts overlying the ribs of the outer wall of the cavity are raised as a single flap, or two or three small flaps are formed (Jacobson), according to the size of the cavity, condition of the patient, and the predilection of the operator. The smaller the flap the less is the hæmorrhage and shock; and, too, if the first flap be centrally located and the rib removed, further procedure at that time can be deferred, if need be, and yet the patient's condition will have been improved by the primary measure. With the large flap these considerations are scarcely applicable. After exposure of the ribs by either method, they are separated from the remaining soft tissues, by means of a slightly curved elevator, to the full extent of the cavity, and divided at the limits of exposure with a fine saw or bone-cutting forceps, and removed. The periosteum should be removed either with or following the enucleation of the rib.

The Remarks.—Unless in all radical methods the thickened parietal pleura of old cases and the associated tissues are removed along the line of bone section, and the empyemic cavity is thoroughly exposed, scraped, cleansed, wiped out, drained at the dependent portions, and, if need be, lightly packed with aseptic gauze, satisfactory relief need not be expected.

Shœde's operation is applicable to all cases with greatly thickened pleura. In this method a U-shaped incision—beginning in front at the outer edge of the pectoral muscle, on a level with the axilla (fourth rib), extending below to the lowest limit of the pleura (tenth rib), and behind up along the vertebral border of the scapula to the second rib (Fig. 1467) —is made down to the bony frame of the chest. This flap is dissected from the ribs, and the scapula and the subscapularis muscle are raised from the trunk. The ribs from the second downward are resected subperios-

teally from the costal cartilages to the tubercles. The intercostal structures and the pleura are removed with large blunt scissors, and the surface is curetted, thoroughly cleansed, the flap replaced, and the borders are united together, with the expectation of securing primary union.

The Comments.—The scapula should be drawn forward out of the way as the posterior incision is made. After removal of the ribs, the remaining tissues are cut away, beginning at the fistulous opening, if one be present, and passing to divide the posterior border first, thus reducing the bleeding to a minimum. Pinching of the vessels between the thumb and fingers before division will lessen the loss of blood. The return of the flap to the opening often leaves an incomplete closure above, which, however, finally heals.

Delorme forms an osteoplastic flap extending from the third to the sixth rib, with the pedicle above and posteriorly (Fig. 1101). In front the ribs and intercostal tissues are severed; at the upper and lower borders the intercostal tissues, behind the ribs, are divided and perhaps resected to a limited extent, and the flap is turned backward. The surfaces are thoroughly curetted, cleansed, and freshened, and apposed by returning the flap in place and uniting its borders with sutures.

If the periosteum be left behind along with the parietal pleura, etc., care should be taken to keep the tissues in apposition to the walls of the cavity, or the rapid development of the new bone may negative the attempt at cure. If one flap only be made it is usually of an oval (Schede) or rectangular form (Delorme), with the base upward to facilitate drainage. A single vertical incision (Gould) with lateral displacement and retraction of the tissues can be employed if the cavity be somewhat narrow. *Fenger* practices the removal of rib fragments of diminishing lengths, beginning at the center of the cavity in those in which the transverse diameter is the greatest at that point. If the vertical diameter be the greater, this surgeon practices the same plan of procedure, only much shorter portions are removed, for obvious reasons. The second rib is rarely resected, on account of its high position and the greater importance of its anatomical associations. The first rib is of still greater significance in these respects, and should be let alone, except in the rarest of instances. From the third to the seventh inclusive are the ribs usually resected, and from the tubercles to the cartilages, if need be. In extensive excision the shock may be great, and the deformity will be pronounced. The lung will not resume the usual position, but the parietal soft parts will obliterate the cavity, if adhesion to the lung be secured. A sinus of moderate extent may follow, especially if the apex of the cavity be not likewise occluded.

Fig. 1467.—The operation of thoracoplasty, Schede's method.

If the patient have tubercular disease the outlook is much impaired, and the simpler methods are advisable, at least as preliminary measures. Each case must be estimated according to its assets, as to the variety, extent, and time of operation, and as to whether an extensive procedure be made at all. All of the unyielding bony wall should be removed in every instance, if cure is to be expected.

The After-treatment.—Gymnastic exercise and forced expiration (breath gymnastics) constitute the main measures directed to restoration of symmetry. High elevations exercise a curative influence.

The Results.—The deformity is not cured, and, in fact, is increased by the operation, but may diminish later. The danger of amyloid degeneration is obviated, and substantial cure may arise. The shock is often great, and corresponding care should be exercised to avoid an unfavorable issue from this cause.

Decortication of the Lung.—*Fowler* in 1893 practiced this measure to relieve the lung from the hindrance to expansion due to a greatly thickened pleura incident to empyema.

The Operation.—Make around the orifice leading to the empyemic cavity an elliptical incision wide enough to include the opening; extend the extremities of this incision parallel with the ribs, anteriorly and posteriorly, sufficiently to correspond to the limits of the underlying morbid process, going down to the ribs, and perhaps forming two triangular flaps by cutting upward two inches and a half from one extremity and downward the same distance from the other; resect portions of two or more ribs corresponding to the limits of the empyemic cavity—and determine the capacity and extent of the cavity and the extent and amount of the overlying morbid product; begin at the border of the opening in the chest wall and isolate the pleura from the overlying tissue by blunt dissection down to the diaphragm; isolate the diaphragm in a similar manner toward the median line, carefully separating any pericardial attachments; isolate the visceral layer of the pleura upward from the morbid product, cautiously avoiding injury to the expanding lung; complete the isolation prudently of all the attachments to the visceral and parietal pleura, drain and close the wound.

The Remarks.—The movements of the diaphragm and heart hinder the removal. When the patient's condition will not approve the giving of general anæsthesia, the special anæsthesia may be employed instead. Isolation of the costal portion should precede that of the visceral, since then the expanding lung is less exposed to danger than when the reverse is practiced. The fingers and ends of blunt curved scissors are efficient means of isolation. Sometimes decortication can be quite easily done, again only a part and perhaps none can be safely detached from the lung. If only time for a single detachment can be safely employed, visceral isolation should have the precedence. Then the lung is relieved. Not always does the lung expand after operation. The earlier the attempt is made the easier can it be accomplished. Tuberculosis complicates the effort.

The Results.—Three operative deaths are reported in 41 operations addressed to either viscera, parietal, diaphragmatic or parts of pleura, singly

or combinedly. *Fowler* reports 2 deaths in 20 cases of visceral isolation, and no deaths in 2 cases of parietal visceral isolations.

Caries and Necrosis of the Ribs and Sternum.—*Thoracotomy* is practiced for the relief of this condition, and commonly with eminent success. Caries and necrosis of these structures follows sometimes injury, resection, syphilis, and typhoid fevers. The ribs from the fourth to the eighth are most often diseased, and usually near the middle portions. Such complications as empyemia, burrowing of pus, causing abscess at distant situations —i. e., of the back, abdominal wall, and even remoter parts—are noted. Rarely indeed are the pleural cavity and lung secondarily involved. The seat of the disease of the rib is usually characterized by the presence of an abscess or of a sinus. Usually operative relief is simple and effective. A horizontal, straight, or a T-shaped incision is made over the seat of the disease, the skin and muscles are conjointly reflected, the abscess is isolated, preferably without opening it, and dissected away, followed by cleansing of the parts with an antiseptic solution. A free incision is made down upon the long axis of the diseased bone (Fig. 1458) in the line of a sinus when present, the extent of the disease is determined, the bone exposed and cut off outside of the affected limits, preferably with a Gigli-Haertel saw (Fig. 1457, *n*), perhaps with a bone forceps. The diseased bone is removed, the associated morbid products dissected and scraped away, the parts thoroughly flushed with an antiseptic solution, the flaps returned to place, and the borders sutured together with catgut. In the instance of the sternum the fistulæ are slit up in the line best intended to secure good observation and drainage of the diseased area. The diseased products are cautiously removed by means of the trephine, periosteotome, bone gouges, scoops, etc. (Fig. 374, vol. i), remembering that the anterior mediastinum may have been invaded. The posterior surface of the sternum may be diseased more extensively than at first seems apparent. Abscess and sinus associated with caries and necrosis of those structures should be carefully sought for, scrupulously cleansed by scraping and douching, and independently drained.

The Remarks.—The preservation of the upper end of the sternum is especially significant because of its mechanical association with the ends of the clavicle. Disease of the posterior surface of the sternum is apt to be insidious, and may become quite extensive and pus point even at the intercostal spaces at the sides before the gravity of the cases is fully appreciated. The fact that the pericardium may be intimately associated with the posterior surface of the bone suggests the need of care in the manipulations incident to the treatment of the bone and mediastinal abscess.

The Results.—The immediate results of operative treatment are highly favorable. Final cure is often much delayed because of the frequently specific nature of the trouble, the inaccessible locations of the disease, and the tortuous outlines of the sinuses, to say nothing of the complications of an organic character.

Tumors of the Ribs and Sternum.—The primary tumors of these structures are comparatively infrequent, the secondary are exceedingly rare. Tumors of an innocent nature, and those limited to the bones and cartilages, are not, as a rule, difficult to remove; but those of extensive growth,

especially of a malignant nature, present frequently complex problems and insurmountable obstacles to removal for consideration. Thorough aseptic method and free exposure of the seat of disease are essential elements of the technique. A large, oval, musculo-cutaneous flap, with dependent convexity, located so as to facilitate observation and manipulation, should be made. The bone is severed at the outer limits of the disease by saw, forceps, or chisel and mallet (Fig. 374, vol. i), and cautiously raised, along with the morbid growth from the body, by means of careful dissection. If the growth is malignant, the extent is problematical, and the possibility of complete removal is uncertain. Extensive areas of disease involving the sternum, ribs, pleura, and even the pericardium, have been successfully removed and the patients have recovered. An important feature of the removal of these growths relates to whether or not the disease is extrapleural or intrapleural. In the former instances the danger of operative involvement of the pleural cavity is a matter largely under the control of the surgeon, who, by the employment of judicious forethought and cautious technique, will rarely indeed invade this cavity unless the pleura itself be involved in the disease. When, however, the removal of malignant growths is attempted, the invasion of the pleural cavity must necessarily be frequent and often extensive if practical benefit is to follow operative practice. Therefore, the special dangers of sudden and persistent pneumothorax, of hæmorrhage, of shock, of infective pleuritis, etc., force themselves at once to the front. The prevention and successful control of the grave consequent complications of these operations is a matter of pronounced importance. Shock and hæmorrhage are the dangerous features in operations in cases of non-pleural involvement. They should be anticipated and met along the lines that characterize their presence in operations on other parts of the body. In intrapleural involvement, pneumothorax, hæmorrhage, and shock are serious complications, and the first is truly formidable when suddenly occurring in the presence of either of the others. However, it ought to be recognized that not infrequently little or no special disturbance attends surgical invasion of the pleural cavity in those cases. *Parham's* investigations show that "little or no disturbance" followed in about 40 per cent, "moderate disturbance" in about 24 per cent, and "quite stormy manifestations, even threatening life," in about 36.5 per cent of the cases in which the pleural cavity was opened. The larger the hole, and the longer time it remained open, the severer were the effects. The severe manifestations occurred in pneumothorax of the right side nearly twice as often as in that of the left. Parham's investigations emphasize the practical wisdom of operating before involvement of the pleura, of establishing preliminary adhesion of the surfaces by sewing, etc., of prompt closure of the tear by the finger, by a compress, or suture. *Keen* closed the opening in the pleura by stitching the lung to the border.

The induction of extrapleural pneumothorax (page 1271) and of deep inspiration with final closure of the wound are available methods of treatment.

Matas and *Parham* regard the *Fell-O'Dwyer* apparatus (Figs. 1468 and 1469) for forced artificial respiration as an agent of great significance.

The latter surgeon considers it an essential part of the operative armamentarium, " intended to revolutionize this field of surgery." *Northrup* *
extols the apparatus as " an efficient aid in carrying on prolonged artificial
forcible respiration." *Matas* † has since devised a modified apparatus.

FIG. 1468.—The Fell-O'Dwyer apparatus in action, showing the bellows, assorted sizes
of intubation cones, and the conductor. An intubation cone of suitable size is
pressed into the larynx so as to prevent the escape of air between it and the laryngeal wall. The bifurcated arrangement of the conductor regulates the amount of
air introduced by means of the thumb acting as a valve at the point of escape.

The following is substantially the text of a communication from Dr.
Fell descriptive of the apparatus employed by him for the purpose of inducing forced respiration (Fig. 1469) : " The apparatus which I have used
and found so efficient in cases of forced artificial respiration, consists of a
bellows (*a*), the size of which has been determined by my experience. It

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* Presbyterian Hospital Medical and Surgical Report.   January, 1896.   Vol. I.
† Amer. Med., January 18, 1902.

is operated as follows: Three movements for inspiration and three for expiration. This will produce eighteen or twenty respirations per minute when worked at a convenient rate of speed. The attempt to operate it so that a single movement represents an inspiration would almost certainly
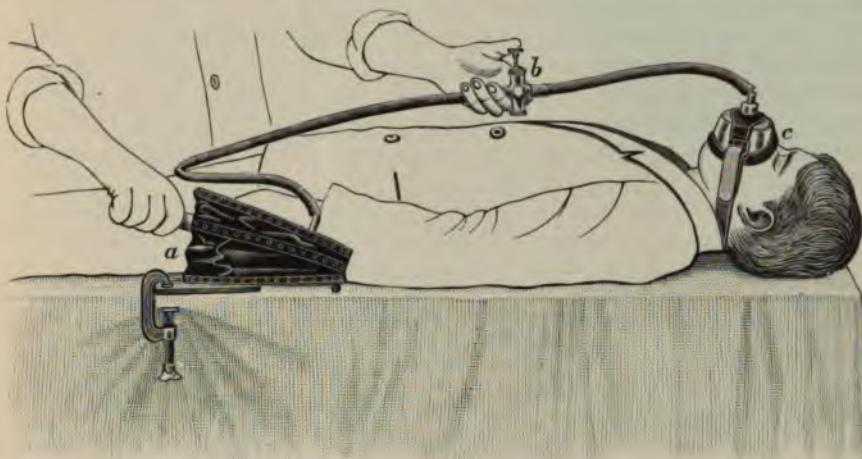
FIG. 1469.—Forced artificial respiration, Fell's improved apparatus. *a*. Bellows. *b*. Air valve. *c*. Face mask.

defeat the purpose for which the apparatus is intended. The anæsthetic can be administered by placing a sponge or gauze, properly saturated with the anæsthetic, over or in proximity to the opening through which the air enters the bellows. A simple arrangement constructed on the principle of the chemist's wash bottle, by means of which oxygen can be made to pass through a tube into the air valve, thence with the anæsthetic into the lungs, can be attached. This device, along with that for mingling oxygen with the inspired air, makes a complete outfit for the purpose. Next to the bellows is the air valve (*b*), with which it is arranged to act. The operator presses down the piston of the valve a full stroke during three movements of the bellows, thus causing inspiration by permitting the air saturated with the anæsthetic to enter the lungs through either of the selected channels—i. e., the face mask (*c*), the intubation cone (Fig. 1468), or the tracheotomy tube (Fig. 1470). The piston is then released until three movements of the bellows are made, which permits expiration to occur. Before the operation is begun the mask should be snugly fitted to the face to prevent any uncertainty in this respect. If during inspiration it does

FIG. 1470.—The tracheotomy tube and rings used in forced artificial respiration, Fell's method.

not fit so that the cheeks may bulge somewhat without air escaping by the sides of the mask, its best action can not be attained. Frequently a pad or folded handkerchief placed over the bridge of the nose will secure a tight fit. If an intubation tube be employed, a rubber tube from the air valve

can be connected with the former and good inflation can then be secured, provided that the end of the tube is of proper size to fit the trachea. My best results in long-continued respiration have been secured by means of tracheotomy and the occluding of the trachea with a suitably sized ring screwed to the end of the tracheotomy tube (Fig. 1470). But for operative work on the thorax the other methods appear to be the better suited. The size of the bellows and the manner of its operation should be suited to the requirements of individual cases—i. e., one movement for inspiration and one for expiration in a child, two movements for inspiration and three for expiration in a youth, and three for inspiration and the same for expiration in an adult will usually suffice."

Sauerbuch's [*] air chamber, which is of ample size to hold the patient, and three others is an agency of established usefulness in operations complicated with pneumothorax, as has been demonstrated by Mikulicz.

Aspiration only, and aspiratory drainage (page 1265 et seq.) in cases of effusion, should be employed. Apparatus employed for the ordinary purposes of aspiration of fluid from a cavity may be utilized in like manner for the withdrawal of air by aspiration.

The Precautions. Be sure and cut wide of malignant disease, removing its manifestations entirely when practicable. Avoid operation in these cases when complete removal is regarded impossible, except for the purposes of euthanasia. The thin pleura lying beneath innocent growths will be torn in their removal unless great care be exercised. Hæmorrhage is often profuse in removal of innocent growths, and always so and persistent in removal of the malignant.

The Results. Of 26 extrapleural operations, 7 died and 19 recovered. Of 51 intrapleural operations, 16 died and 35 recovered. Recurrence followed within a year in 7 of 10 cases of extrapleural, and in 12 of 23 cases of intrapleural operations.

Wounds and Hernia of the Diaphragm.—Attention to the attachments of the diaphragm to the thorax, and to the peculiarity of its structure, is important as preparatory to the consideration of wounds and hernia of the organ. Also its relation to contiguous viscera, and the influence exercised on them by its presence and movements, should not be overlooked. Wounds of the diaphragm often escape a suspicion of their presence, healing without manifest difficulty, or are revealed either on autopsy or by an explorative incision directed to the relief of complicating hæmorrhage, a visceral wound or an acute intestinal obstruction provoked by strangulation consequent to the original injury. The situation, direction, and extent of a wound of the thorax will often suggest diaphragmatic involvement, while other evidence escapes observation. Diaphragmatic herniæ are either of congenital origin or due to injury, and in either instance they may escape detection or thought, until revealed by autopsy or explorative operation. Hernia from either of these causes happens much oftener at the left than the right side. Congenital protrusions occur more frequently posteriorly than anteriorly, and, as elsewhere, their size and shape are regulated by the

[*] The Jour. Amer. Med. Assn., vol. xlii, pp. 930 and 1191. N. Y. and Phila. Med. Jour., June 10, 1905.

characteristics of the opening. In only about 10 per cent of the cases are the displaced viscera provided with a sac, and the great majority of those are of congenital origin. The stomach, colon, small intestines, liver, and even the pancreas, cæcum, and kidney appear in the protrusion, and in point of frequency in the order stated. Stab and contused wounds are most often the exciting causes of this variety of hernia, and of those arising from the former cause but one third suffer at once from the hernial infliction; in the remainder, months and years may elapse before hernia become manifest. At all events, in 88 per cent of the cases death follows sooner or later from the effects of the wound, prompt strangulation covering about 9, and later, about 14 per cent of the deaths. From the aforegoing it follows that wounds of the diaphragm call for prompt explorative diagnosis and repair, irrespective of hernial manifestation. The detection of a wound of the diaphragm is best accomplished by manual examination made through a high median incision in the abdomen. By this means the under surface of this muscle can be carefully and comprehensively examined on either side of the body. If a defect is found, it should be repaired as soon as the condition of the patient will permit.

The surgical treatment of diaphragmatic wounds and hernia may be effected either by way of the abdomen or the chest (Figs. 1192, 1193, and 1278). By the former route the entrance is easy, but the treatment is difficult because of the position of the diaphragm and the influence on the protrusion of negative pressure. The latter route, while readily available, easy of attainment, and opposed to the influence of negative pressure, exposes the pleura and lung to the consequences of thoracic invasion, which in feeble and diseased subjects is often a matter of grave importance. However, as the surgeon in these cases usually opens the abdomen with the view of relieving intestinal obstruction, and meets, perhaps, with an unsuspected strangulated diaphragmatic hernia, which has already infected in a greater or less degree the pleural cavity, and can not be returned safely, if at all, without opening the pleural cavity, it is surely seen that the thoracic route is often essential for the treatment of such cases. A wound of the diaphragm should be suspected when the seat, direction, and depth of the injury are such as to suggest the possibility, and especially when the symptoms do not conform with the history of an injury of a simpler nature. Usually these wounds are explored along the line of injury, the soft and hard parts being turned aside as the needs of observation, arrest of hæmorrhage, and of repair demand.

If the seat of entrance of the penetrating agent be located at some distance below the ribs, a median abdominal incision for diagnostic purposes may be made, followed by a thoracic, if repair from below be impracticable or a hernial protrusion of the diaphragm be present. In the pleural route the recent wound or the adult scar is employed as a guide to the seat of operation. A large flap of the soft parts, corresponding preferably to the seventh intercostal space (Fig. 1278), is made, followed by resection of two ribs of sufficient length to afford the opportunity of careful observation and of prompt adequate repair of the rupture. If a hernia be present, the condition of the protrusion should be carefully noted before reduction is

attempted. If it be gangrenous, a commodious median abdominal incision should be made at once, the tissues around the point of escape thoroughly isolated with rubber dam and aseptic gauze before an attempt at reduction is made. And, too, the contents of the intestine with which it is continuous, should be pushed aside and retained before reduction, not only to increase the opportunity of manipulation, but also lessen the danger of extravasation. Whenever a lack of proper vital integrity of the protrusion is suspected, the final treatment and observation should be carried on through a median abdominal incision. Resection of gangrenous intestine and the formation of artificial anus can not be practiced through the chest walls. When thoracic observation establishes the belief in the integrity of the protrusion, it should be thoroughly cleansed, returned to the abdomen, and the opening in the diaphragm repaired by sewing. The wound of the thorax is closed, and the patient treated otherwise as for hernia elsewhere.

Penetrating Wounds of the Thorax may perforate the diaphragm and invade the abdominal cavity, doing great damage to the contents of the cavity without arousing an early suspicion of the fact essential to successful treatment. Although the direction taken by the traumatic agent and the force employed, together with their characteristics, ought always to be carefully considered, still the seat of the infliction is a matter of prime significance. Penetrating wounds occurring below the sixth rib should arouse apprehension because of the liability of diaphragmatic and of abdominal invasion, unless they are directed upward to a degree preventing these contingencies. In cases of this kind of uncertain, of probable, or of assured invasion of the diaphragm exploration along the course of injury should be practiced until the wound of the diaphragm is exposed and repaired. Injury of the subdiaphragmatic structures should be repaired by way of the abdomen, not through the diaphragm by way of the thorax. The former plan affords ample opportunity for observation, repair, and drainage, of which the latter is comparatively barren.

The Precautions.—A careful scrutiny of the protruded part is necessary before an attempt at reduction is made, especially if there is reason to believe that the vitality of the hernial protrusion is impaired. Vigorous traction in reduction should not be practiced in any instance, as relief can be had if only a small incision into the thorax is made. If air have already entered the thorax, or the opening be a free one, or the passage through it by the side of the neck of the hernia of a small hollow instrument for admission of air be practicable, the making of the thoracic opening may be avoided. It should be kept in mind that the addition to the already depressed state of the patient of a pneumothorax may cause of itself a fatal issue; therefore, air ought not to be permitted to enter the pleural cavity except when a discreet use of other methods of reduction has failed. The introduction of the finger through the opening by the side of the hernia is apt to injure the gut at that situation, and should not, therefore, be harshly done. Instead, a small grooved instrument should be introduced at the side, and the opening increased by cutting, remembering always that septic matter may at once escape through the opening into the abdomen. Con-

tused wounds of the abdomen and chest may cause rupture of the diaphragm with all of its manifestations. The possibility of injury of the pericardium and lung should not be overlooked.

The Remarks.—The technique of repair, of cleansing, and of drainage in these cases is similar in all important respects to that of surgery of the serous cavities generally. The purse-string suture, supplemented by the interrupted Lembert suture, is favorably regarded by Williams. The ever vigilant omentum frequently indeed plugs a diaphragmatic the same as it does other abdominal openings within its reach. Fatal issues quite too often afford the opportunity for a diagnosis that at least should have been suspected before. In the instances of aseptic wounds the ribs may be sutured in place by union of the denuded ends with fine silver wire. The results were considered already in the beginning of the discussion. Wounds of the thoracic contents are briefly considered under the various subdivisions of thoracic operations.

Hæmothorax.—The presence in the pleural cavity of a greater or less amount of blood, dependent on a wound of a vessel of the thoracic wall, of the lung, or of an intrathoracic viscus or vessel, is denominated hæmothorax. The seat and age of the wound, together with the amount of the bleeding, will indicate quite pointedly the vessel or viscus involved. In the great majority of instances the bleeding will have ceased already when the patient is first visited by the physician, and the primary aim should then be to maintain quiet to prevent recurrence of the hæmorrhage. Later, the question of absorption of the blood will need consideration. Fortunately, the strong tendency to rapid and complete absorption of even large amounts of blood from the pleural cavity without manifest local disturbance favors the exercise of discreet waiting for the evidences of degenerative changes before active steps are taken. When local and constitutional symptoms indicating the presence of pus appear, the case falls under the category of empyema, and is best treated by the operative measures addressed to that affliction. If hæmorrhage recur, or be progressing at the time of the first visit, prompt measures for arrest must be employed at once to prevent further loss. If the loss of blood arise from the wound of a vessel of the thorax, plugging of the wound, followed promptly by ligature of the bleeding ends under local anæsthesia, should be employed. When, however, the escape has a deeper and more obscure origin, is persistent and dangerous to the life of the patient because of the increasing loss of blood, or from its direct interference with the respiratory capacity, operative practice may then be regarded as the only measure that will afford relief. Operation under these circumstances is a serious matter indeed, and should always include preparation for the prompt and effective use of a saline transfusion.

Aspiration of the thorax may effect the removal of a sufficient amount of the blood to afford relief from the respiratory oppression without provoking fresh hæmorrhage. If this simple measure fails to afford the requisite aid, explorative entrance of the chest by raising an osteo-cutaneous flap of suitable size, and so located as to provide the opportunity for free inspection and proper repair of the injury, should be cautiously practiced (Fig. 1101). After removal of the blood, the seat of escape should be sought

for at once, and the hæmorrhage arrested by catching or clamping the bleeding points or surfaces, followed by suitable repair of the damaged structure. The bleeding points of injured vessels are closed by ligature. Injured viscera are treated according to the nature of the wound and the length of time safely at the command of the surgeon. Small, shallow wounds of the lung, and those demanding instant relief, may be satisfactorily treated by the introduction of iodoform-gauze plugs, one end remaining outside of the chest. But in all instances in which plugging is employed the gauze should be carried to the bottom of the wound, even though the entrance requires enlargement for the purpose; otherwise hæmorrhage will not be fully arrested. Tying of the bleeding surface or opening with a ligature has been practiced successfully, but in the latter instance is exposed to the risk of not controlling entirely the divided structures, especially of the deeper parts of a wound. The use of continued or interrupted sutures of any form is open to the objections that they invade the air cells, puncture the vascular structures, and may fail to command entirely the divided surfaces of deep wounds. In superficial wounds sutures have been satisfactorily employed. After repair, the parts are thoroughly cleansed, drainage provided, flaps restored to place, and so united as not to interfere with drainage, the wound is dressed aseptically, patient placed on the injured side, and quieted with small doses of an anodyne.

The Precautions.—Miscellaneous probing of a wound of the chest should not be practiced. The cautious use of a silver probe or of a finger clothed with a tight-fitting aseptic rubber cot (Fig. 163, vol. i) may be of service in determining the direction of the injury and the probability of entrance to the chest, in the absence of other signs. Chest wounds should be promptly and aseptically closed at once, unless especially contraindicated. After entrance to the chest, the blood should be removed as rapidly as possible in order to discover and arrest bleeding at once. A strong movable light will facilitate the search for the seat of injury and contribute much to hasten repair. Careful scrutiny is sometimes required to detect the seat of a slight injury of the lung, especially when received at the borders of that viscus. Transfusion may be required during the course of the operation, possibly before and quite certainly afterward.

The Remarks.—Thorough asepsis should be practiced in all respects. The unusual tendency to fluiding of blood in the pleural cavity renders aspiration for the purpose of removal entirely feasible and often unexpectedly successful. A U-shaped flap of the soft parts is commonly made and turned aside; limited portions of two or three ribs are then excised, often subperiosteally, and removed, followed by a smaller flap of the pleura and intercostal structures. Injuries of the heart are treated under a separate heading (page 1295). Immobilization of the chest so far as may be consistent with the demands of breathing, and the use of opium, to restrain coughing, are to be commended. In those instances in which much disorganization of the lung is present, and in which pressure is requisite to control the bleeding, sufficient gauze may be introduced into the thorax to effect the purpose. Catgut sutures are efficient agents in these cases.

The Results.—In 86 cases of hæmothorax from penetrating wounds of

the chest, 22 recovered and 44 died without operation; the remainder are not stated. Of the 22 treated by puncture or incision to relieve pressure on the lung, 4 died (Nélaton).

Abscess of the Lung.—The history of voluntary surgical attack on the lung is a long one, replete with indications of persistent effort, interrupted by frequent discouragement, and finally crowned with practical success. Abscesses vary in size, form, number, and situation—facts that should be recognized as influencing the outcome of operative practice. Usually the diagnosis of abscess is established by aspiration before the need of operation is announced. Sometimes the latter follows immediately the determination of the need by the former, and is consequently a part of the procedure.

The Operation.—Under thorough aseptic preparation and local anæsthesia, introduce at the center of the field indicating the seat of the abscess, as determined by the physical signs, a short, strong, aspirating needle (Fig. 1457, *k*) (with a lumen of about half to three quarters of a line in diameter) already connected with an aspirator; open the stopcock controlling the aspiration as soon as the end of the needle is well buried in the tissues; slowly and cautiously press the end of the needle into the chest, carefully watching at the same time for the appearance of pus in the glass segment of the tube. When pus appears, leave the needle in place as a guide to the abscess if relief is to be sought at once. Otherwise, slowly withdraw the needle, noting carefully the site, deviation, and depth of penetration for after guidance. Close the seat of puncture with collodion, and while noting the effect of the exploration prepare for operative relief. In operating raise a U-shaped musculo-cutaneous flap of ample dimensions; with the convex portion posteriorly, and with the needle as a guide to the pus, divide anteroposteriorly carefully along the course of the needle with a scalpel the various tissues down to the parietal pleura, excising limited portions of one or more ribs if need be. *If the pleural surfaces are adherent* to each other, continue the dissection along the needle into the abscess, which is then carefully evacuated and drained. *If adhesions are not present*, and the case is urgent, unite the pleural surfaces with each other by sewing with chromicized catgut supplemented with gauze packing, and continue the dissection. If the case is not urgent, pack the wound with gauze, and at the end of two or three days finish the operation under the protection of the newly formed adhesions.

The Precautions.—The precautions incident to penetration of the chest in empyema, etc. (page 1262 *et seq.*), are of equal force in this condition. If pleural adhesion have not taken place, collapse of the lung will follow invasion of the pleural cavity, and seriously hinder, if not defeat entirely, the safe evacuation of the pus. Therefore, one should not, unless unavoidable, divide the pleura until after adhesions are established. With a nonadherent pleura the movements of the lung can be seen and felt through the exposed parietal layer of the membrane, and a needle thrust through it into the lung will oscillate with the respiratory movements, not moving simply upward and downward with the chest wall as in the instance of pleural adhesions. It is often comparatively difficult to divide or pierce a

thickened adherent pleura; moreover, the history of the physical signs of disease of the pleura will indicate adhesion. Should pus escape into the pleural cavity during evacuation of the abscess, free dependent drainage of the cavity should be established at once, and the cavity thoroughly flushed with a saline solution. The fibrous bands often noted by the finger in exploring abscesses should be cautiously treated, as they not infrequently support and conceal important blood-vessels. The introduction of the fingers into the cavities and flushing is not advisable. In the instances of non-adhesion, gauze pressure only is too uncertain to be regarded as an acceptable substitute for sewing with catgut. In deep introduction of the exploring needle, the advancing end should be directed away as much as possible from important structures. Inasmuch as the abscess may be missed entirely on exploration, or the pus be too thick to flow, or have been nearly discharged by coughing, a microscopical examination of the contents of the lumen of the needle should be made to determine the nature of its contents before this means of detection is discontinued. Needles of increased caliber may be employed if pus be found in the lumen of the smaller, keeping in mind the fact that it is not always possible to locate an abscess by this method of practice. Abscess and empyemic cavities communicating with a bronchus should not be flushed, as the fluid may enter the bronchi and suffocate the patient. *Janeway* warns against the danger of giving anæsthetics in such cases, and emphasizes the admonition by repeated instances within his own knowledge in which patients have been suffocated by pus while insensible to its presence in the lung, because of anæsthesia.

The Remarks.—The means for making a passage through the lung tissue into the abscess cavity are quite numerous and variously indorsed by operators. Trocar and cannula, the knife, the cautery, and blunt dissection are commonly employed. *Paget* regards with especial favor the use of a fine director fitted closely around the needle of an exploring syringe. They are caused to pierce the lung combinedly, and after determining the presence of pus by aspiration, the needle is withdrawn, leaving the director in place to serve as a guide to the abscess. Along the director dilating agents of increasing size are successively carried, thus opening a commodious channel into the abscess. Cautious dilatation is essential, otherwise serious bleeding may be provoked, requiring that the wound be plugged to arrest the hæmorrhage. Cautery is a safe and efficient agent when employed with discretion. The advance through the tissue with this agent should be slowly made and the instrument removed cautiously, and only after the tissues are seared sufficiently to permit the withdrawal without tearing away the cauterized tissue and causing severe hæmorrhage. In superficial abscess blunt dissection may be safely employed. Hard pulmonary tissue may be safely cut, the soft as safely treated with cautery. The cautery and gauze tampons should always be at hand to arrest hæmorrhage. Cavities at the apex of the lung drain readily into a bronchus; those at the base do not, and for apparent reasons.

The distance of the proposed entrance of the needle should be indicated upon it before beginning the act, to avoid needlessly dangerous encroachment on the contents of the thorax. The sewing together of the pleural

membranes in the absence of adhesion lessens the danger of collapse of the lung, and correspondingly facilitates the ease and rapidity of subsequent operative efforts. *Tuffier* commends transpleural examination of the lung for localization of abscess. The parietal pleura is separated from the chest wall for a sufficient extent to meet the required purpose, and through it the physical state of the lung is estimated by the hand, and thus the abscess is located. However, this additional severity to the operation added to the increased opportunity of infection, does not favorably commend this modification. If an abscess communicate with a bronchus, a tampon of gauze should be employed to close the opening into the bronchus, and thus aid the function of respiration, otherwise a drainage tube may be employed. *Beck* introduces a narrow strip of gauze into the abscess cavity, cleanses the pleural cavity, packs it with gauze, and administers morphin to control the cough. He causes expulsion of the pus from the cavity by causing the patient to blow out from time to time with the mouth and nose closed.

The Results.—*Paget* reports 14 complete recoveries in 42 operations for simple abscess; 3 recovered with fistula, 24 died, and in 1 the result is unknown. *Fabricant* reports 38 cases of operation for abscess, with 29 cures. *Taüfert* reports 5 operations for abscess—all successful. *Réclus* reports 17 operations for abscess following fibrinous pneumonia, with 14 cures and 3 deaths.

Bronchiectasis.—Operations on dilated bronchi are very unsatisfactory. (The majority of patients do not improve at all, and the few that do as a rule rapidly become worse.) While a single well-formed cavity may be amenable to operation, the facts that there are usually multiple dilatations, and that at the best but temporary benefit need be expected, offer a meager benefit for the danger incurred. The means of detection of the cavity and the general technique of the operative procedure are substantially similar to those employed for abscess of the lung.

The Results.—*In bronchiectasis, Tuffier* reports 45 operations with but 7 improvements; *Paget* reports 12 operations, with 8 deaths and no complete recoveries.

Gangrene of the Lung.—Gangrene of the lung is a secondary disease, and therefore largely influenced in extent, location, and circumscribed state by the nature of the disease or injury which it complicates. Therefore, it is important in considering the advisability of surgical effort to note whether or not the associated cause leads to the circumscribed or diffuse variety of gangrene, and whether it is likely to be superficial or deep. Uncircumscribed or diffuse gangrene of the lung is much less suited for operation than that located in less delicate and important functional parts of the body. And in the lung or elsewhere in the body, circumscribed superficial gangrene is the most favorable for operative treatment. Operation should be performed early enough, if possible, to anticipate the occurrence of sepsis, perforation of the pleura, and consequent pyæmia and hæmorrhage.

The Operation.—The advantages of physical diagnosis and of explorative puncture are utilized to locate the seat of the disease. Turn aside a U-shaped musculo-cutaneous flap corresponding to the site of the suspected gangrene; cautiously resect a portion of one or more ribs, carefully avoid-

ing injury of the pleura. *If adhesions are not present,* separate the parietal pleura from the chest wall and practice transpleural palpation of the lung, in order to locate accurately by touch the seat of the disease. Having located the seat of the disease, resect the ribs sufficiently to permit of easy approach to and treatment of the gangrene; sew together around the superficial area of disease by means of a continuous chromicized catgut suture, introduced in the manner of the domestic "back-stitch" (Roux), the non-adherent pleural surfaces; pack the outer limits of the wound with gauze, and introduce at the center of the area an aspiration needle; cut through the parietal pleura freely, thus exposing the seat of the disease; open into the gangrenous area with a trocar and cannula, or with a cautery; cut away with knife or scissors the superficial gangrenous portions, wiping the parts with gauze pads. If fluid be present in the pleural cavity it should be removed, the cavity thoroughly cleansed, drained, and packed with gauze before the gangrene is treated. If ample adhesions be present between the serous surfaces there is no need for delay in the operation.

The Precautions.—It is wise to pack the wound after sewing together the pleural surfaces, and wait four or five days before attacking the gangrenous area, if the patient's condition will warrant the delay. An infected pleural cavity should be kept thoroughly cleansed, and dependent drainage should be maintained and gauze packing employed during the treatment of a gangrenous lung. Gangrene extends downward toward the base of the lung; therefore the opening into the chest should be extended in a downward direction for the purposes of treatment. The pleura is attached less firmly to the intercostal structures than to the borders of the ribs; consequently the separation should be commenced at the former situation. In separating the pleura from the chest wall care should be exercised to prevent tearing; the separation should be done slowly with the fingers toward the pleura (Tuffier). In sewing the pleural surfaces together the visceral layer should be picked up during inspiration, and in order to secure a reliable line of apposition the continuous suture, preferably the "back-stitch" variety, should be introduced. When gangrene is deeply situated in the lung, the cautery at a dull-red heat is the safer agent to employ in the treatment.

The Remarks. Prompt operation, if practicable, should follow the withdrawal of pus from a lung cavity, by aspiration in the absence of adhesions at the seat of puncture, to avoid infection of the pleural cavity. Not infrequently cases treated by simple puncture of the cavity through the chest wall with trocar and cannula, followed by drainage, the tube being introduced through the latter agent, have satisfactorily recovered. Pleural adhesion should have preceded the employment of this measure. Counter drainage of a cavity in the lung may be deemed advisable. Incisions for gangrene, as incisions for abscess that fail to locate the seat, as an not necessary; frequently, occur, and not infrequently in a few days a rich discharge takes place through the incision and cure quite as much follows. Gangrenous and abscess cavities should be washed out and in a flushed, especially when the cavity communicates with a bronchus or opens the pleural cavity to

the danger of infection. The X rays aid in determining the location of abscess and gangrene of the lung.

The Results.—*In gangrene of the lung* without operation, 75 per cent of the cases die (Réclus). *Sonnenberg* reports 47 operations with 35 recoveries. *Fabricant* reports 26 operations, with 16 cures and 10 deaths. *Taüfert* reports 10 operations, with 7 cures and 3 deaths. *Réclus* reports 13 cases, with 11 cures and 2 deaths.

Tumor of the Lung.—According to Tuffier, a patient with primary malignant tumor of the lung has never been subjected to operation. However, secondary sarcomata have been successfully removed. We can not favor this practice, because nothing tangible can be offered to those suffering from secondary manifestations commensurate with the dangers and discomfort attendant on operations for their removal at this situation. In the instance of hydatid growths the conditions are different. The lungs and pleura suffer next in frequency to the liver from hydatid disease.

The Operation.—Puncture and incision are the surgical methods of practice that will be considered, and the former is mentioned for the purpose of condemnation rather than encouragement. Puncture even with a small needle for diagnostic purposes should be promptly followed by incision, to anticipate fatal pleural inflammation from leakage, and often lung complications of even a prompter and more fatal outcome.

The technique of operation by incision is not dissimilar in principle to that employed in like treatment of hydatid growths connected with serous membranes elsewhere in the body. The tumor is located by the physical signs, and perhaps identified by means of a small hypodermic needle. A flap is raised and turned aside and a portion of one or more of the ribs resected, followed by exposure of a limited area of the parietal pleural. If the pleural surfaces are adherent to each other, the operation is continued; if not, the wound is stuffed with gauze for four or five days, in order to establish adhesions. When adhesions are formed over a sufficient area to afford proper protection to the pleural cavity from hydatid infection, the tumor is opened along the course of an exploring needle by means of cautery or incision. The contents of the cavity are evacuated without the aid of irrigation or curetting. A short, soft, rubber drainage tube of large caliber is introduced into the cavity and the wound dressed with an abundance of gauze.

The Precautions.—Care should be exercised to cause a wide enough area of adhesion to prevent the entrance into the pleural cavity of infecting agents. The union of the pleural surfaces by sewing should not be relied upon to the exclusion of packing, from fear of leakage; full reliance can be placed on the packing for adhesion purposes. Preparation for prompt examination of the fluid withdrawn by the needle and for operative action should have been made before the needle is inserted, in order that incision may at once follow the diagnosis of hydatid disease. Irrigation and curetting of the cavity should not be practiced, because of the great danger of invasion of the bronchial tubes. The major part of the contents of the cyst may be cautiously removed by the finger or a small spoon, the remainder escaping with the subsequent discharges.

85

The Remarks.—The cough that often attends is lessened by anodynes. Symptomatic and other complications are treated as they arise.

The Results.—*Paget* regards the death rate as being from 50 to 60 per cent without surgical treatment, and states that the suffering of those who recover is severe and prolonged. The death rate from puncture is variously estimated, being from 69 (Maydl) to 27 (Thomas) per cent. The death rate from incision is estimated to be from 16 (Thomas) to 20 (Lopez) per cent.

Tuberculosis of the Lungs.—Active surgical interference in pulmonary tuberculosis has been quite extensively practiced and widely discussed at various times; and although striking instances of relief are not infrequently reported, the proposition itself has not met with extended professional approval. The reasons for this fact are so apparent as not to require consideration at this time.

Tubercular Cavities.—In not a few instances has the incision of tubercular cavities been followed by temporary relief, but rarely indeed by final cure. The fact that only palliation was expected seems to justify further effort in this regard, unless it shall appear that success is attained at a too great sacrifice. The localization of the incision in the treatment of these cavities is indicated by the physical signs. The exposure of the parietal pleura is accomplished in the same way and is guided by the same reasons as for abscess, etc. In these cases the pleural surfaces are, in a great majority of the cases, already adherent, consequently the operator proceeds at once to invade the cavity by means of a trocar and cannula or with cautery. The first two agents are employed more frequently in this than in the previously considered conditions. However, if hæmorrhage is feared because of the great depth of the cavity beneath the surface of the lung, or for any other reason, cautery is still the preferable agent for use. After the opening is established and the contents are evacuated, cleansing of the cavity by wiping or spraying with soothing aseptic medicated fluids is indicated. The removal of the deleterious matter from the cavity is commonly promptly followed by a subsidence of the constitutional symptoms and an abatement of the local suffering and annoyance. As the result of these changes, the general condition of the patient improves for a longer or shorter period, when finally the advance of the disease in other parts of the lungs, or the increase in the gravity of the complications already established, weaken the patient and finally cause death. If the patient is so fortunate as to be inflicted with but a single cavity or the tendency of the disease be toward recovery, he secures a prolonged respite and perhaps a final cure, or possibly it may be said that he recovers sooner and with less suffering because of the operation.

The Precautions.—Great care should be taken to prevent the entrance of air into the pleural cavity, for the reason that the addition of the effects of a pneumothorax to that of the already crippled state of the lungs might seriously complicate matters, if not become the cause of speedier death. Careless manipulation of the walls of a cavity may cause troublesome hæmorrhage, and irrigation distressing cough and suffocating sensations. A circumscribed pneumothorax may be mistaken for a tuberculous cavity.

The opening in the chest wall should be so extended as to secure good drainage.

The Remarks.—The X rays may aid in the diagnosis of the location of a tuberculous cavity. The employment of antiseptic solutions in the treatment of these cavities has not proved satisfactory. The use of a solution of tuberculin for this purpose has been extolled, but with questionable judgment. Sometimes contiguous tuberculous collections empty into the primary cavity. A failure to find an accumulation of tuberculous products may be followed soon by their escape through the pulmonary incision.

The Results.—Little can be said of favorable results. It is estimated that of 100 cases operated on 5 die from the operation, 70 live only two weeks afterward, and 15 less than four. *Paget* reports 8 cases with 6 betterments and 2 deaths.

Resection of a Tuberculous Deposit in the Lung.—The removal of a part or the whole of the apex of the lung for the purpose of cure of tuberculosis is not a pratical proposition, as the limits of the disease can not yet be established. The area of operative approach is small, being bounded above by the clavicle, below by the second rib, and laterally by the sternum and pectoralis minor (Fowler). The opening is made in front through a U- or II-shaped incision. The importance of the clavicle and the first rib require that their sacrifice be not made in the furtherance of a so unrequiting and meager return. The second and third ribs are therefore resected if need be.

Tuffier exposed the parietal pleura through the second intercostal space, and without resection of a rib established an extrapleural pneumothorax by separating the pleura from the chest wall, gaining at the same time the opportunity of locating the pulmonary induration by means of transpleural palpation. He opened the pleura, grasped with forceps the indurated portion, dragged it through the intercostal space, removed the tubercular mass, returned the lung to the chest, dressed the wound without drainage, and the patient made a prompt recovery.

The Comments.—The production of an extrapleural pneumothorax presses together the pleural surfaces, preventing the entrance of air into the pleural cavity. The suturing together of the respective layers more rarely accomplishes the purpose. The portion of tissue removed is transfixed at the bone and securely ligatured, the diseased portion is cut away, the lung returned to the chest, and the wound treated without drainage.

The Results.—*Paget* reports 5 operations with 1 complete recovery and 4 deaths. *Réclus* asserts that " resection of a tuberculous focus ought to be proscribed." *Willard* * has lately published statistics on the operation of pneumonectomy.

Temporary pneumothorax for the cure of pulmonary tuberculosis, suggested by an Italian surgeon some years ago, has been lately presented to the profession in an interesting and able manner by Murphy,† of Chicago. The pneumothorax is caused by injecting nitrogen gas into the pleural cav-

* Journal of the American Medical Association, August 26, 1903.

† Journal of the American Medical Association, July 23, 30, and August 6, 1898.

ity of the diseased lung, thus imitating Nature's efforts at cure by placing the lung in correspondingly similar conditions. The gas is introduced by means of a needle governed by a stopcock, without especial pain or unfavorable symptoms. The gas will remain for months unabsorbed in the thorax and the introduction can be repeated when required. *Murphy* regards the introduction of the gas into a vein as the chief risk attending the use, and reports strikingly suggestive results following the plan of treatment under his own observation. The writer commends the study of Dr. Murphy's able paper on the subject while suspending judgment and awaiting more conclusive proofs of the virtues of the practice.

Mediastinal Thoracotomy.—The thorax can be opened in front or behind for the purpose of removal of obstruction in the œsophagus or bronchi, and for the relief of morbid processes in the mediastina. The intricate anatomical relations and the difficulty of proper treatment afterward render the adoption of the anterior route for the removal of bronchial and œsophageal obstructions well-nigh impracticable. *Posterior thoracotomy* is well suited for the requirements of drainage, and presents less complicated anatomical problems for solution. A knowledge of the anatomical features of the operation can be gained from text-books on anatomy. *Nasiloff* in 1888, followed by *Potarca* and by *Quénu* and *Hartmann*, directed attention to opening the chest posteriorly, mainly for the purpose of reaching the œsophagus and bronchi in cases of persistent obstruction. *Rushmore*, in his somewhat recent striking case of bronchial obstruction, determined to open the chest in front, but was obliged to desist early in the course of the attempt because of the alarming state of the patient. Rushmore has since given preference to the posterior method of practice in these cases.

The writer in 1895 presented to the American Surgical Association a paper on this subject, from which the following extracts bearing on the technique of the operation are substantially taken.

The Position of the Patient.—The patient should be placed obliquely on the abdomen, with the shoulders so supported as to cause the least possible interference with respiratory movements of the thorax. The side to be attacked should be uppermost, and the body securely fixed in this position, in order that no disturbance of it shall interfere with the line of vision, nor lead to a misdirection of the manipulative methods employed for the purpose of relief. The scapula should be drawn forward out of the way. Each assistant should be at his post, and have received careful instructions regarding his duty.

The Ascertainment of the Proper Seat of the Obstruction.—This step is a very important one, and should be determined with great care and deliberation since the proper location is essential to a good view of the deep parts of the wound, and to the precise and delicate steps of the most important part of the technique. The center of the field of operation should, if practicable, correspond to the seat of obstruction or disease, for obvious reasons. If the obstruction be in the œsophagus, and of sufficient density when percussed by a metallic instrument to produce sound, a stethoscope applied to the back, especially to the right side, will define the situation by fixing the point of greatest density. Also the comparative relation of the

obstruction to an individual vertebra may be estimated by ascertaining by means of a graduated bougie its distance from the upper incisor teeth. This comparative relation, and possibly the nature of the obstruction, can be established by means of radiography. Having determined numerically the body of the vertebra contiguous to the obstruction, the tip of the spinous process of this vertebra and the one above should be carefully located. It will be noticed that as a rule the tip of the spinous process of a vertebra is opposite to the rib of the next vertebra below, and therefore the tip of a spinous process will indicate quite correctly the rib nearest the center of the field of operation.

The Shape and Size of the Flap.—A flap about three inches square, including the tissues down to the ribs, when reflected inward, affords ample space for work and observation. It should correspond to three ribs, the middle one of which should be the center of the operation field. The parallel incisions should be made carefully, otherwise the knife may pass between the ribs and enter the pleural cavity.

The Treatment of the Ribs.—Portions of not less than three ribs should be displaced from the angles to the outer extremities of the transverse processes, in order to gain proper room for observation (Fig. 1471). The middle one of the three should be cautiously divested of the soft parts on the external surface and the borders by means of a sharp periosteotome, carefully avoiding the parietal pleura. The pleura is then separated from the inner surface of the rib by means of a strong antiseptic silk ligature carried beneath it by an aneurism needle and moved to and fro until the rib is free the entire width of the wound. A Gigli-Haertel saw is then drawn into position by the ligature, and the rib is divided at the limits of exposure and removed.

The pleura is then cautiously separated from the inner surfaces of the intercostal tissues and the ribs immediately above and below the opening. The fingers should be used for this purpose, and the separation made only during expiration. Attention is next directed to increasing the size of the thoracic wound by the displacement of a similar portion of the adjacent ribs. The intercostal vessels between these ribs are tied at the outer and inner limits of the wound. The ribs are then divided in the same manner as the first, carefully maintaining the nutritive integrity of the intercostal tissues at the outer borders of the fragments. The fragments are then turned outward, while hinged as it were to the contiguous ribs by the intervening intercostal structures, in which intercostal vessels pass undisturbed (Fig. 1472). This method of treatment of the ribs secures for the fragments the best possible nutritive advantages when returned and fastened in position, and also it reduces to a minimum the danger of laceration of the pleura by the bony extremities.

The Prevention of Hæmorrhage.—Prompt ligature of all bleeding points, and careful manipulation in the approach to the obstruction, offer the measures best intended to prevent the occurrence of hæmorrhage.

The Location of the Obstruction.—The site of the obstruction in the œsophagus is easily made out by the combined aid of the finger in the wound and a bulbous bougie in that passage. If the pleura be gently pushed out-

85*

ward with the fingers, the movements of the bougie in the œsophagus can be easily seen at the right side in the greater part of the cavity. A strong electric light is a very important aid at this time. If the obstruction be in a bronchus, this tube can be easily located by the finger before it is exposed to view. The characteristic incomplete rings of the bronchus are readily felt as they lie directly forward and about an inch and a half from the opening into the chest.

The Avoidance of Important Structures.—This desideratum relates not only to approaching the situation of the obstruction, but also to the passage
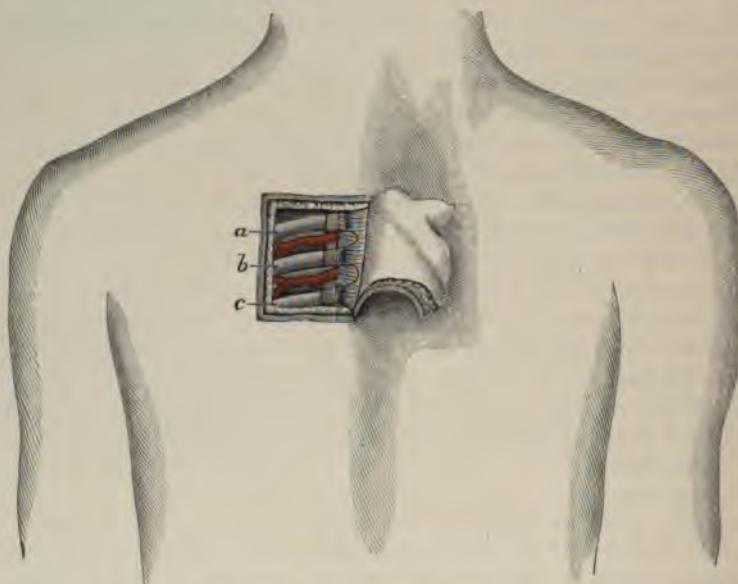
FIG. 1471.—The operation of posterior thoracotomy, the author's method. *a, b, c* indicate the three ribs involved in this illustration.

containing it. The vena azygos, the aorta, the pulmonary vessels, and the pneumogastric nerves must be cautiously treated.

The Removal of the Obstruction.—If the obstruction be in the œsophagus or a bronchus, the incision for removal should be made in the long axis of the tube, and of sufficient length to permit the withdrawal without laceration of the structures. Long-handled instruments with short blades and biting surfaces are essential, not only on account of the depth of the wound, but for the purpose of economizing space and permitting the entrance of light.

The Treatment of the Incised Tube.—The tube should not be closed since the presence of mucous and inflammatory products that rapidly supervene as the result of the obstruction, to say nothing of the similar products arising from the manipulative procedure itself, will prevent union. An iodoform tamponade supplemented with a centrally located drainage tube will meet the indications.

The Replacement of the Fragments.—The central rib fragment is not replaced, but the upper and lower fragments are, being fastened in position by means of silkworm gut or fine silver wire. If a proper aseptic state of the parts can be maintained, the bone fragments will be nourished sufficiently by the vascular hingelike attachments to the adjacent ribs to secure union.

The Adjustment of the Flap and Dressing of the External Wound.—The former step must be carefully considered, as the flap can not be accurately adjusted at the outset on account of the presence of the drainage agents described. The major dressings in ordinary use for aseptic results will suffice in this instance.

The Precautions.—The utilization of a good light and the X ray, the control of bleeding, the avoidance of laceration of the pleura and prompt closure of the opening, the cautious approach to the point of obstruction, the careful observation of the patient's condition and prompt treatment of bad symptoms, the arrest of the operation when demanded, and forced artificial respiration (page 1274) should characterize the procedure.

The Remarks.—The operation bespeaks urgent requirement and grave consideration, coupled with consummate care and forethought. It should
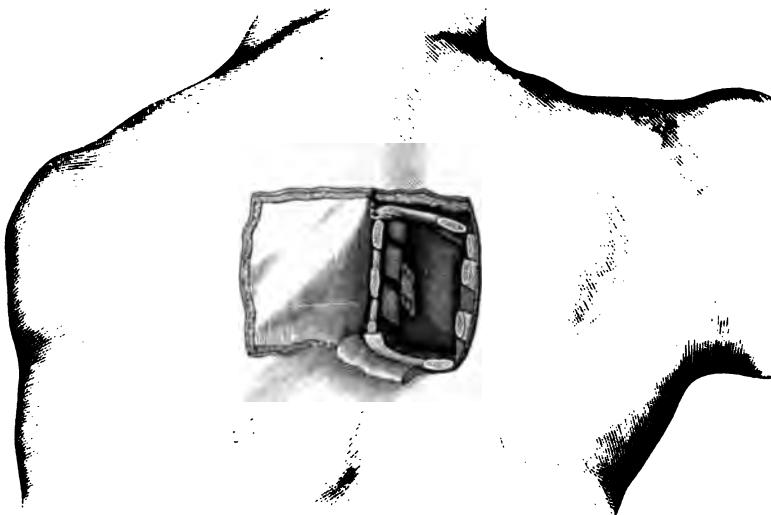
Fig. 1472.—The operation of posterior thoracotomy, author's method. Middle rib removed, the upper and lower ones turned aside, exposing the pleura and bronchus.

not be attempted until other means of relief are tried and have failed; nor should delay in the attempt have sacrificed already the strength and courage of the patient. Aseptic methods, great caution, and the ability to scrutinize the steps of the procedure are the technical guides to safety and success. The advantages of the posterior over the anterior incision for the purpose of exposing the bronchi, the œsophagus, and mediastinal growths are too obvious almost to require mention. For the complex anatomical relations

of the anterior way are substituted the much simpler ones of the posterior.
The great desideratum of all wounds, and especially those of septic associa-
tions, is good dependent drainage. And if for no other reason than this the
posterior way possesses an advantage which the anterior can not offset what-
ever else may be said in its favor. If the pleura be torn, the opening
should be closed at once by tying or stitching with fine silk.

The seat of pressure on the œsophagus from without can be located in
the same manner as that employed when the lumen is obstructed from
within. While non-malignant involvement of the posterior mediastinum
is amenable to surgical treatment, the expectation of adding comfort or
longevity in malignant infliction at this situation, by surgical means, is
doubtful. In cases of an assured location of a foreign body deeply situated
in a bronchus, *Turc* suggests that the approach to the obstruction be made
through the lung tissue by means of actual cautery.

Curtis, in 1896, performed posterior thoracotomy for the relief of ob-
struction of a bronchus of four or five days' standing in a boy about eleven
years old. Because of the pioneer nature of the operation on the living
patient, and the established reputation of the surgeon, the full details of
the operation are quoted:

"*The Operation.*—Chloroform anæsthesia. The patient was turned
over upon his face, one shoulder resting upon a sandbag, so as to render
respiration easier. A quadrangular flap was raised from the posterior sur-
face of the chest, with its base outward at the scapula and its free edge near
the vertebral spines of the fourth, fifth, and sixth dorsal vertebræ. (The
tips of the dorsal spines are on the same level as the angles of the ribs
attached to the corresponding vertebræ.) This flap comprised the skin and
fascia, and the aponeurosis of the trapezius, and was reflected outward.
Some fibers of the rhomboid and of the serratus posticus were divided, and
these muscles were then retracted outward, while the splenius was retracted
inward, and the transverse processes of the vertebræ being exposed, the
attachments of the longissimus dorsi were separated from them, and all the
deep muscles were detached from the ribs and retracted outward. Portions
of the fourth, fifth, and sixth ribs, about three inches in length, were then
resected subperiosteally from the tuberosities outward. The layer made up
of the periosteum and intercostal muscles was then carefully divided, so as
not to injure the pleura, the intercostal arteries being secured as they were
severed. The pleura was carefully but widely detached from the contents
of the posterior mediastinum and from the posterior chest wall, so as to
give access to the root of the lung. The bronchus was easily reached, but it
was difficult to expose it, so as to enable an incision to be made into it, on
account of the azygos vein which crossed it. The respiratory movements
of the lung, heaving under the detached pleura, were also very embarrass-
ing, and finally, as the pulse began to be affected seriously, the wound was
packed and the operation suspended.

"The following day the packing was removed, chloroform being given
again, and the pleura being now somewhat adherent to the lung and the
latter less troublesome, the bronchus was successfully opened on its posterior
wall without hæmorrhage. But even then our difficulties were not com-

pletely surmounted, for, to our great disappointment, it was found impossible to recognize the foreign body with the forceps introduced into this opening. The foreign body, partly macerated, was similar in consistence to that of the bronchial forks, and it appeared to be farther away from the bifurcation of the trachea than at first. Forceps was also passed down through the tracheal wound, but still the foreign body was not found. Finally, it was detected through the lung by pressing on the latter with the fingers, and it was determined to cut directly down upon it, as even then no forceps could be made to pass to the spot where it lay. The detached parietal pleura was first secured to the surface of the lung by two or three deep silk sutures, the ends of the latter being left long, and the lung being held steady by the threads, an incision was made with the thermo-cautery knife. The foreign body could be felt in this opening, but it still eluded the grasp of forceps, and the condition of the patient forbade any further delay, so a drainage tube was introduced to the bottom of the opening made in the lung and the entire wound packed. Whether the pin was too firmly fixed in the wall of a bronchus, or whether some tissues still remained undivided over it, was impossible to determine, but if the patient had survived, it is probable that the foreign body would have found its way out of the deep wound which led directly down to it. The patient reacted well, and on the following day showed only the ordinary symptoms of a severe pneumonia. Signs of consolidation had been present in the lower lobe of the right lung from the first, and these had increased daily. Fever and dyspnœa, due to this consolidation, gradually increased, and terminated in death about forty-eight hours after the last operation. A post-mortem examination showed no pneumothorax and no pleural effusion. The foreign body lay in one of the secondary bronchi close to the end of the drainage tube, the pin having entirely penetrated the wall of the bronchus."

Curtis turned the base of the flap outward, leaving the soft parts attached to the posterior border of the scapula, thus increasing the thickness and mobility of the base of the flap. He resected the corresponding ribs, lessening a little the time of operation. The employment of the X rays may serve to establish the exact location of the obstruction, thus enabling the surgeon to open the chest at a point nearest to, or at a dependent point in relation with the foreign body, unite the pleural surfaces, reach and remove the object through a canal formed by cautery, or permit of direct removal by means of fine, sharp-pointed, strong pincers passed through the intervening living tissues, as has already been accomplished in at least one instance. The writer submits the following propositions:

1. That, in certain cases, when other means of relief have failed, attempted relief from œsophageal or bronchial obstruction by way of the posterior mediastinum may prove justifiable.

2. That below the arch of the aorta the œsophagus is reached better from the right side; above the arch it can be reached from either, though better from the left side.

3. That the attempted removal of obstructions situated below the body of the ninth dorsal vertebra is not justifiable, owing to the great difficulty and increased danger of exposing the œsophagus at that situation.

4. That posterior entrance to the mediastinum is more easily, quickly, and safely accomplished than the anterior, and offers better results than does the latter method of practice.

The following valuable deductions of Willard, based on experiments on dogs, are worthy of special notice in this connection:

1. The collapse of the lung, when the chest is opened, is an exceedingly serious and dangerous element in the operation, adding greatly to the previous shock, and threatening to overpower the patient.

2. The difficulties of reaching the bronchus, especially upon the left side, are exceedingly great, and the risks of hæmorrhage are enormous.

3. The incision into the bronchus necessarily after closure of the wound of the chest wall leads to increasing pneumothorax.

4. The delays in the operation from collapse of the patient must necessarily be great. Rapid work is impossible when the root of the lung is being dragged backward and forward at least half an inch in the efforts occasioned by air hunger, and precision is almost impossible.

5. To reach the bronchus is sometimes feasible, but to extract a foreign body from it and to secure the patient's recovery is as yet highly problematical, and will require many advances in technique. The anatomical surroundings are those most essential to life.

Milton's Operation (*Anterior Thoracotomy*).—Milton's method of entrance to the thorax contemplates the exposure and treatment of the contents of the mediastina, especially the anterior and middle, through an incision made in front at the median line of the chest.

The Operation.—Under strict asepsis make an incision in the median line from the thyroid cartilage to the base of the ensiform cartilage, going down to the bone at the sternal part of the cut; expose rapidly the trachea to a point opposite the episternal notch; detach the fascia from the episternal notch outward at either side to the insertion of the sterno-mastoid muscle; separate and displace downward with the finger from the sternum the important structures lying immediately beneath its upper end; divide the sternum from above downward nearly through along the line of incision in the soft parts with a saw, omitting the ensiform cartilage; disconnect the ensiform cartilage from the bone above with scissors or bone-cutting forceps, carefully avoiding the underlying structures, especially the peritonæum; insert strong, broad-hooked retractors into the sawed border of the sternum at either side of the division and make moderate traction outward and upward; draw downward the ensiform cartilage with a hooked retractor and pass from below upward closely beneath the sternum along the saw line a spatula; complete from below upward the severance of the sternum with scissors or bone-cutting forceps, cautiously protecting subjacent tissues from injury; draw with the rectractors and pry apart with a broad chisel the divided borders of the sternum sufficiently to expose restraining tissues, which are cautiously severed with scissors or knife. In this manner a gap two or more inches in width is made through which the anterior mediastinum may be readily exposed to view and examination. Exposure and exploration of the middle and even the posterior mediastinum can now be effected after careful separation of the pericardium from the right pleura,

The removal of morbid growths and foreign bodies should be conducted with consummate care, not only to avoid infection and hæmorrhage, but to obviate fatal injury of important structures. Blunt dissection, supplemented with discreet use of cutting implements in the effort, should be practiced. The closure of the mediastinum is easily effected by bringing in contact the sawed borders of bone and firmly wiring them together with five or six silver sutures. After the introduction of gauze drainage at the upper and lower ends of the sternum, the wound of the soft parts is closed and dressed in the usual manner.

The Precautions.—For reasons signally apparent the importance of thorough asepsis in each detail of this operation can not be overestimated. Also the intricate relations of highly important structures with each other and with the sternum are such as to demand the closest thought before beginning the operation. Since the division of the sternum and separation of the bone segments arrest costal breathing, ample means for artificial respiration should be at hand to promptly and effectively meet respiratory demands. In emphysematous subjects increased danger of division of the pleura is incurred. If dyspnœa from obstruction is present at the outset, tracheotomy should be performed at once, and provision for the same should be at hand if this complication be anticipated.

The Remarks.—The hardest and thickest part of the bone is at the upper end. Separation of the bone segments is easier and safer when begun at the lower end of the sternum, because the intrapleural space is wider (Fig. 1476, dotted lines) and the anatomical relations less important than at the upper extremity (Fig. 206, vol. i). The chief restraining tissues lie above near the innominate vein and below at the xiphoid junction. Wounds of pleural and peritoneal membranes, especially the former, should be closed immediately by pressure to avoid pulmonary collapsing and possibly a fatal issue. Immediate artificial respiration should be utilized in lung collapse. Wounds of each of these structures should be closed by sewing as promptly as possible. Morbid processes involving the sternum should be removed when practicable the same as if elsewhere located. The unavoidable amount of hæmorrhage is insignificant.

The Results.—The outcome of the several operations by this method commend its further employment, especially when directed to morbid states of the anterior and middle mediastina.

OPERATIONS ON THE HEART AND PERICARDIUM.

Not until quite recently has this field of operative effort been given the consideration commensurate with its great importance.

The Anatomical Points.—The heart corresponds in front to the lower two thirds of the sternum, and parts of the adjacent costal cartilages and of some of the left ribs. Its upper limit is at about the third costal cartilages, its apex at a point located three quarters of an inch within and one inch and a half below the nipple. It extends three inches to the left, and about one inch and a half to the right of the median line of the sternum. Behind the sternum are situated more than two thirds of the right ventricle, the

right auricle, a large part of the left auricle, and a portion of the anterior coronary vessels. The base of the heart corresponds at the back to the sixth, seventh, and eighth dorsal vertebræ. The anterior portion of the pericardium above, lies from three to five centimeters (one and two tenths to two inches), and below about one centimeter (four tenths of an inch) behind the sternum. At the base of the pericardial sac anteriorly there is a cul-de-sac (a) of from one to two centimeters (four to eight tenths of an inch) in depth, normally collapsed, but distended in the event of pericardial effusion, when it corresponds to the region of the sixth intercostal space (Fig. 1473). Toward this cul-de-sac (a) are the efforts of the operator directed in aspiration and in drainage of the pericardium. The distended pericardium extends above to the first space, below to the seventh cartilage, to the right from two to three centimeters (eight tenths to one and two tenths inches) beyond the edge of the sternum, and
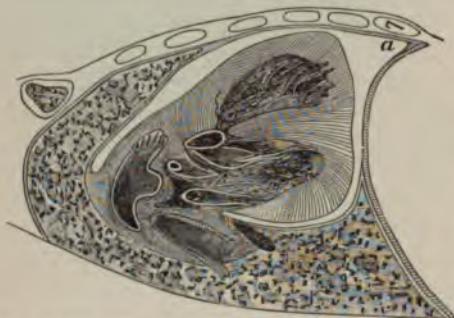
FIG. 1473.—Vertical section showing relations of the heart and a considerable pericardial effusion to the parietes; reclining. a. Cul-de-sac. 7. Seventh costal cartilage.

to the left a little beyond the normal line. At the interpleural space the pericardium can be entered without involvement of the pleura. This space corresponds to the lower triangular portion of the anterior mediastinum, and is bounded on either side by the respective anterior pleural reflections, and below by the diaphragm (Fig. 1474).

The exact location and size of this space vary. Right pleural adhesions or a left pleurisy with effusion, carry the space to the right of its normal position, and vice versa. Adhesions of both pleuræ increase the size of the interpleural space, while a double pleurisy with effusion diminishes the space and presses the pericardium backward. In abdominal distention the diaphragm or lower boundary of the interpleural space is pushed upward, so that a puncture of the fifth space might enter the abdominal cavity. A pericardial effusion, other things being equal, tends to increase the size of the interpleural space. The anterior pleural folds are loosely adherent to the pericardium, from which they can be stripped, but intimately bound to the triangularis sterni, from which they can not be separated. A ridge of dense cellulo-adipose tissue designates the line of pleural reflection. The triangularis sterni underlies the sternum and costal cartilages. Upon it rests the internal mammary artery (Fig. 1475), which above lies from one half to one and a half centimeters (two to six tenths of an inch), and below from one to two centimeters (four to eight tenths of an inch) from the sternal border. A cartilaginous bridge unites the sixth and seventh costal cartilages (Fig. 1476, d), and sometimes one exists also between the fifth and sixth. The sixth space near the sternum is a very narrow one, and is sometimes obliterated.

Aspiration of the Pericardium.—This operation is performed for hydro-pericardium, hæmopericardium, and for diagnosis in suspected pyoperi-cardium. The needle should be a very fine one for diagnosis. That of *Pravaz* is much employed. Evacuation should be done with a *Potain* appa-ratus and a needle or trocar.

The Important Facts.—Involvement of the pleura and injury to the heart and internal mammary vessels should be avoided. The determination anteriorly of a composite pericardial area not covered by pleura in any one of a large number of normal subjects has been made by Voïnitch-Siano-jentsky (Fig. 1474). The long axis of this space which would be the resultant site of greatest safety extends from the seventh left chondro-ster-nal articulation vertically upward to the level of the lower border of the fifth chondro-sternal articulation. This line lies chiefly behind the sternum but touches upon the sixth space, just at the sternal margin. The same investi-gator likewise demonstrates the relation of the heart surrounded by a consid-erable effusion to the chest wall (Fig. 1473). This illustrates how puncture in the sixth space can be made direct, and also that in puncture through the fifth space the puncturing agent should be directed very obliquely down-
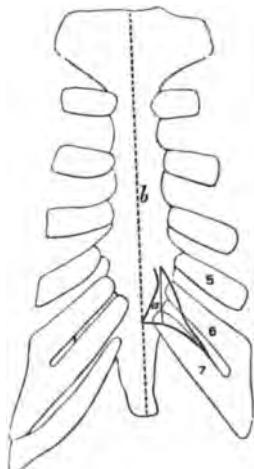
FIG. 1474.—Composite normal interpleural space of Voïnitch-Sianojentsky. *a.* Re-sultant line of greatest safety. *b.* Me-dian line. *5, 6, 7.* Fifth, sixth, and seventh costal cartilages.
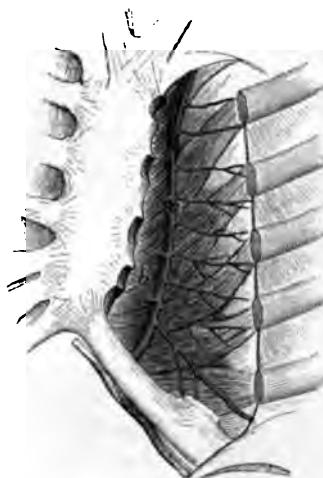
FIG. 1475.—Internal mammary artery lying on triangularis sterni muscle. *a.* Artery. *b.* Muscle.

ward to avoid injury to the heart. The mammary vessels can be avoided by puncturing close to the sternum or well external to them.

The methods of aspiration are those of Delorme and Mignon, of Bai-zeau and Delorme, of Voïnitch-Sianojentsky, and of Dieulafoy (Fig. 1476).

Delorme and Mignon.—Make a vertical incision at the left border of the sternum over the fifth and sixth intercostal spaces. Introduce the needle preferably in the sixth space, but if this space is too narrow, through the fifth, close to the sternum for about eight millimeters (three tenths of

an inch), corresponding to the thickness of the bone; then direct the needle inward close to the posterior surface of the sternum for one or two centimeters (four or eight tenths of an inch), to avoid the pleura, after which raise the handle of the instrument a little and plunge the needle downward and inward through the pericardium.

Baizeau and Delorme (1).—Through a short skin incision plunge the needle obliquely downward and inward in the fifth left intercostal space, close to the sternum, until the pericardium is reached and entered.

Voïnitch-Sianojentsky (2).— Pass the needle directly from before backward in the sixth left intercostal space close to the sternum.

Dieulafoy (3).—Aspiration is made through the fourth or fifth space, preferably the latter, at a point about six centimeters (two and four tenths inches) from the sternal margin. Entering by a short vertical incision pass the point of the needle carefully through the intercostal muscles, after which direct the instrument obliquely inward, almost parallel with the inner surface of the chest wall. The tense surface of the pericardium is detected and the instrument passed through it. The point of the instrument should be carefully held downward and inward, flattened against the pericardial sac to prevent injury to the heart.

FIG. 1476.—Aspiration of the pericardium. *a.* Anterior edge of lung. *b.* Border of pleura. *c.* Internal mammary artery. *d.* Cartilaginous bridge between sixth and seventh cartilages. *Sites of Puncture.—* *1.* Baizeau and Delorme. *2.* Delorme and Mignon, also Voïnitch-Sianojentsky. *3, 3'.* Dieulafoy. Dotted lines correspond to borders of pleura.

The Remarks.—Lejars recommends the method of Baizeau and Delorme for diagnostic puncture. The objections to the method of Dieulafoy are that the instrument always passes through the pleura, and that the heart, from its relation with the fifth space, is liable to be injured. Owing to the pleural involvement, aspiration should never be practiced here for pus.

The Results.—The results of aspiration in hæmorrhagic pericarditis, where the general condition is not too unfavorable, are good. In pericarditis with effusion the results vary according to whether the fluid is of a tuberculous or of a rheumatic origin. Early aspiration here is better than late. In the hydropericardium of Bright's or cardiac disease, aspiration can be only a palliative measure.

Pericardiotomy. — Pericardiotomy is performed for exploration in wounds of the pericardium, for suture of wounds of the heart, and for drainage of pus. Fig. 1474 schows relation of pleura to fifth and sixth cartilages.

The Operation.—Make either an ⊥-shaped incision (Fig. 1101) or a single oval incision with its base at the sternum. The vertical portion of the

former should lie a finger's breadth external to the left border of the sternum, and extend from the upper border of the fourth to the lower border of the sixth or seventh cartilage. The sixth cartilage is first resected, and the fifth and fourth also may be if more space be needed. Cut the intercostal muscles close to the sternum and reflect the flap outward, exposing the internal mammary artery beneath. The latter may either be ligated, or else drawn outward together with the triangularis sterni and the left pleural reflection, after the dissection of these structures from the sternum and pericardium respectively. Incise the pericardium from below upward between two forceps to avoid injury of the heart. Drain at the lower angle of the wound. In suture of the pericardium bring serous surfaces into apposition. Cartilages can be excised the same as ribs (Figs. 1458 and 1278).

The Remarks.—This operation is practically that of Delorme and Mignon. Voïnitch-Sianojentsky has proposed three operations for drainage of a small, a medium, and a large effusion respectively, aiming his point of entrance at the interpleural space which he found enlarged progressively toward the left with the increase in pericardial fluid. For a small effusion he would resect the left sixth and seventh cartilages close to the sternum, together with the adjacent portion of the sternum, and sew the pericardium to the aponeurotic opening in the triangularis sterni. For a medium effusion he would resect the left sixth and seventh cartilages adjacent to the sternum without resection of the sternum itself, tying the internal mammary artery; and for a large effusion he would resect the sixth left cartilage external to the internal mammary artery.

Wounds of the Heart.—Wounds of the heart are not so infrequent or so fatal as is commonly supposed. Death may happen instantly or be delayed for many months. *Fischer* collected 452 cases with 84.07 per cent mortality; 104 of these cases suffered immediate death. *Loison* reports 277 cases of the past thirty years, with 84.8 per cent mortality. *Jamain* reports 121 cases, of which 18 per cent died immediately, 69 per cent died after an interval of more or less time, and 13 per cent recovered. *Laforgue* reports 56 cases, of which 32 per cent died immediately, 38 per cent survived for a longer or shorter period, and 30 per cent recovered. Loison reports 23 cases of needle wound of the heart with 14 deaths, of which 1 only was from infection. Eight deaths certainly, and probably the others, were from tearing of the heart, and in all there was distention of the pericardium. The left ventricle, from its anterior position, is the part most often wounded. The auricles, especially the left, may be wounded from the back. In a wound of the heart the pleura is almost always involved, producing a left hæmothorax. *Rehn* and *Bode* claim that small wounds of the heart tend to heal rapidly, while large wounds remain gaping, having a tendency to enlarge in the direction of the muscle fibers.

In estimating the possibility of injury of the heart from penetrating agents, the seat, depth, and direction of the wound are of the greatest importance. These facts, when supplemented by a knowledge of the established relations of the organ to the chest wall, enable one to judge quite accurately by local evidence only if the heart be wounded.

Formerly when the local characteristics of the wound suggested that the heart was involved, absolute quiet, in as comfortable a posture as possible, was enjoined and secured if practicable by anodynes. If symptoms are present or supervened, indicating labored action of the organ from impaired force due to injury, or to direct pressure from pericardial extravasation of blood, the heart's power was stimulated and the labor lessened by removal of the extravasated fluid and the arrest of hæmorrhage. *Latterly* other measures rather than partial are commended. *Paget* reports a case of stab wound complicated with great distention of the pericardium by blood, and attended by severe suffering, in which a successful issue followed phlebotomy. The patient's condition improved, the profound sense of suffocation diminished as the escape of blood progressed to the estimated amount of two pounds. Should bleeding fail to afford relief, and evidences of increasing escape obtain, the removal of the compressing fluid by tapping or incision of the pericardium under local anæsthesia is practiced, followed possibly in the latter instance by repair of the wound itself (page 1301). If blood escape from the pericardial wound the latter should not be tamponed, since not only is the circulation depleted by the flow, but also the danger of compression of the heart is diminished by it.

In the instance of needle wounds the onset of the symptoms is less acute, more slowly progressive, and not so dangerous as in wounds from grosser agents. A simple puncture of the heart is comparatively harmless, but when a needle is left with one end fixed in the thoracic wall and the other planted in the pulsating heart a gradual tearing of the cardiac muscle takes place. Immediate extraction is therefore indicated. The detection of the point of penetration, and of the needle itself by means of the X rays, call for explorative examination and removal. The needle should be removed with a slow, steady rotary movement.

The Suture of Wounds of the Heart.—According to *Hill,*[*] the human heart has been sutured for injury since 1896, 39 times. Of this number, 20 were of the left ventricle, of which 10 recovered and 10 died. Fourteen were of the right ventricle, of which 10 died and 4 recovered; 1 each of the right and left auricle, both died. In 3 instances the seat of injury is not stated, all died. In 7 instances death occurred in from 5 to 22 days from complications. It appears from these statements that wounds of the left are more frequent than of the right; which is not at all strange. It also seems that wounds of the right are much more fatal than of the left ventricle. *Hill* remarks that 19 per cent of perforating wounds are promptly fatal. Auricular wounds are more fatal than the ventricular. Wounds received during diastole are less dangerous than during systole. The perpendicular are more dangerous than the oblique variety, and those of the right ventricle bleed more freely than those of the left. A needle puncture of a ventricle rarely causes hæmorrhage, but a similar injury of an auricle is liable to cause excessive bleeding during diastole.

At the present time there appears to be no doubt, when practicable, that prompt exploration should be exercised to determine the condition of the

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[*] Medical Record, November 29, 1902.

pericardium and heart in case of injury. If the patient be conscious, chloroform should be given; probing the wound should not be attempted. *Gibbon* * regards the prompt formation of an ample osteoplastic flap with the base at the sternum or the reverse as better practice than repeated resections, for the purpose of free exposure of the organ.

The following conclusions of *Hill* are timely and helpful: " Steady the heart before attempting to suture it, either by carrying the hand under the organ and lifting it up, or, if the hole is large enough, introduce the little finger, which will serve the double purpose of stopping the bleeding and facilitating the passage of the stitches.

" Catgut sutures should be used, as wounds of the heart heal in a remarkably short time. The sutures should be of the interrupted kind, introduced and tied during diastole, not involving the endocardium. As few as possible should be passed, commensurate with safety against leakage, as they cause a degeneration of the muscular fiber with its tendency to dilatation and rupture.

" In cleansing the pericardium it should be sponged out, and no fluid poured into the sac.

" It hardly seems necessary to accentuate the fact of the attainment of perfect cleanliness in these operations whenever the urgency of the case does not require instant intervention.

" The wound in the pericardium should be closed, and should symptoms of compression arise, reopen, and drain."

An apparatus for forced respiration will be in order, if the pleura be perforated and collapse of lung follow.

Ricketts † has added much to the knowledge of this topic.

The thorax is opened in the manner previously described (page 1298).

A curved intestinal needle is used in the sewing. It is carried deeply into the cardiac muscle, entering and emerging on either side of the wound at least four or five millimetres (one tenth and half to two tenths of an inch) from the edges, and should never penetrate the endocardium. It is passed rapidly during diastole, which latter is perceptibly lengthened by the manipulation. At a succeeding diastole the thread is drawn through, and at another tied. Proper traction on the uncut first stitch facilitates the introduction of the successive ones by steadying the heart. It is best to suture wounds of the heart in a given case, and in all instances when circumstances will justify the practice. The coronary artery if wounded should be tied.

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* American Journal of Medical Science, September, 1904.

† N. Y. Med. Jour., May 16–23 and June 20–27, 1903.

CHAPTER XVII.

OPERATIONS ON THE URINARY BLADDER.

THE cavity of the bladder may be explored by catheters, by sounds (Fig. 1720), and by searchers (page 1373); inspected by the cystoscope (page 1159) and through an opening above the pubis; its outer surface is examined by rectal and abdominal palpation.

The catheters can be practically divided into the soft-rubber, silk, gum-elastic, and metal varieties. The first two varieties are extremely flexible, and are harmless instruments in the clumsiest hands (Fig. 1482, *a*). It is sometimes necessary that a soft-rubber catheter be provided with a guide in order to properly direct it as well as to overcome any slight impediment in its course (Fig. 1477). The gum-elastic and metal instruments especially modified for distinct purposes will be considered later.

The Care of Catheters and Sounds.—Sounds and metal catheters should be maintained in a perfectly smooth and polished state, and so protected as not to be roughened or dented. These, like other instruments, should be thoroughly cleansed and sterilized before using. If before using either be dipped into alcohol and the alcohol ignited, sufficient sterilization is made to meet the purpose. Metallic instruments can be readily sterilized by passing them carefully in the flame of a Bunsen burner. Sterilized oily substances are good lubricants for the *metal* instruments, and castor oil and fluid albolene are the best examples of these substances. But soft-rubber instruments are rapidly deteriorated by oleaginous substances. *White* and *Martin* recommend the following lubricant for rubber instruments —in fact it may be used for all:

R   Boroglyceride................ ℥iij;
M. Aquæ destil.................. f ℥ix.

However, the agents employed for this purpose are being constantly modified for special reasons. Rubber instruments are not only purified but benefited by boiling, while textile instruments, protected by varnish, soon blister and crack from the effects of heat. Special apparatus for sterilization of all varieties of urethral instruments can be pro-

FIG. 1477.

a. Keyes's catheter guide. *b*. Otis's catheter guide.

1302

cured in the supply stores of large cities. Only suitably sterilized instruments should be introduced into the urethra and bladder, and the same
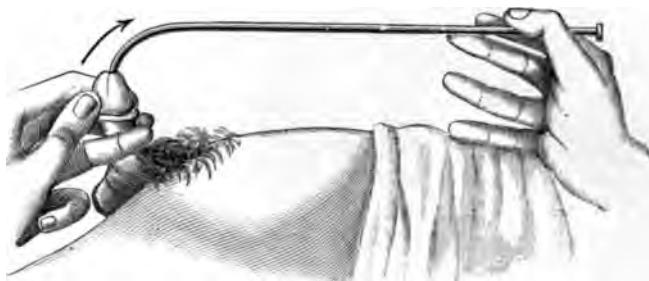
FIG. 1478.—The introduction of catheter, first step. Instrument parallel with abdomen.

precautions should characterize their use as are practiced in general operative procedures. The meatus should be wiped off with aseptic cotton saturated with a sterilized fluid before a sound or other instrument is introduced. The urethra and meatus can be thoroughly sterilized by irrigation with a permanganate solution of 1 to 5,000. Washing out the bladder is practiced by some surgeons, after the introduction into it of an instrument.

The Introduction of a Catheter or Sound into the Bladder.—Select an instrument of a suitable curve and size; place the patient on the back, with

FIG. 1479.—The introduction of catheter, second step.

the shoulders somewhat raised and the thighs slightly flexed on the abdomen, and rotated outward to relax the abdominal muscles; warm and smear the instrument with a properly sterilized substance; stand on the left side

of the patient; grasp the penis with the middle and ring fingers of the left hand and raise it vertically. The catheter or sound is then taken lightly between the thumb, index, and middle fingers of the right hand, and introduced into the meatus held open by the left index finger and thumb. The instrument and penis should now be carried close to the body in the line of the groin, or over and parallel with abdomen (Fig. 1478); the former is the common manner. The penis is then gently drawn over the instrument, which at the same time is carefully pushed, or allowed to enter by its own weight, into the canal (Fig. 1479). After about five inches of the instrument

FIG. 1480.—The introduction of catheter, third step.

have disappeared, the outer extremity should be carried toward the median line of the body and elevated slowly to a vertical position, when its weight will usually cause the advancing end to pass beneath the pubes, after which the upper extremity is depressed between the thighs, causing the point to enter the bladder (Fig. 1480).

The Comments.—In passing a catheter with a stylet, hold the latter firmly in place, or the end may escape through the eye of the catheter and lacerate the urethra. Not infrequently the advancing end, as it passes beneath the arch of the pubes, will hitch upon the triangular ligament. This can be obviated by raising the point of the instrument at this situation by the finger pressed firmly against the median line of the perinæum, accompanied by upward traction on the instrument as the point is being advanced (Fig. 1481); in a word, causing the instrument to hug the roof instead of the floor of the canal. The beginner is apt to carry the handle of the instrument between the thighs too soon, causing the beak to be reversed in front of

FIG. 1481.—The introduction of catheter, disengaging end of instrument from triangular ligament.

the pubes. Under no consideration must violence be employed in introducing a catheter, *ars non vis* being an almost traditional axiom in this connection. The surgeon should always follow the advancing end of the
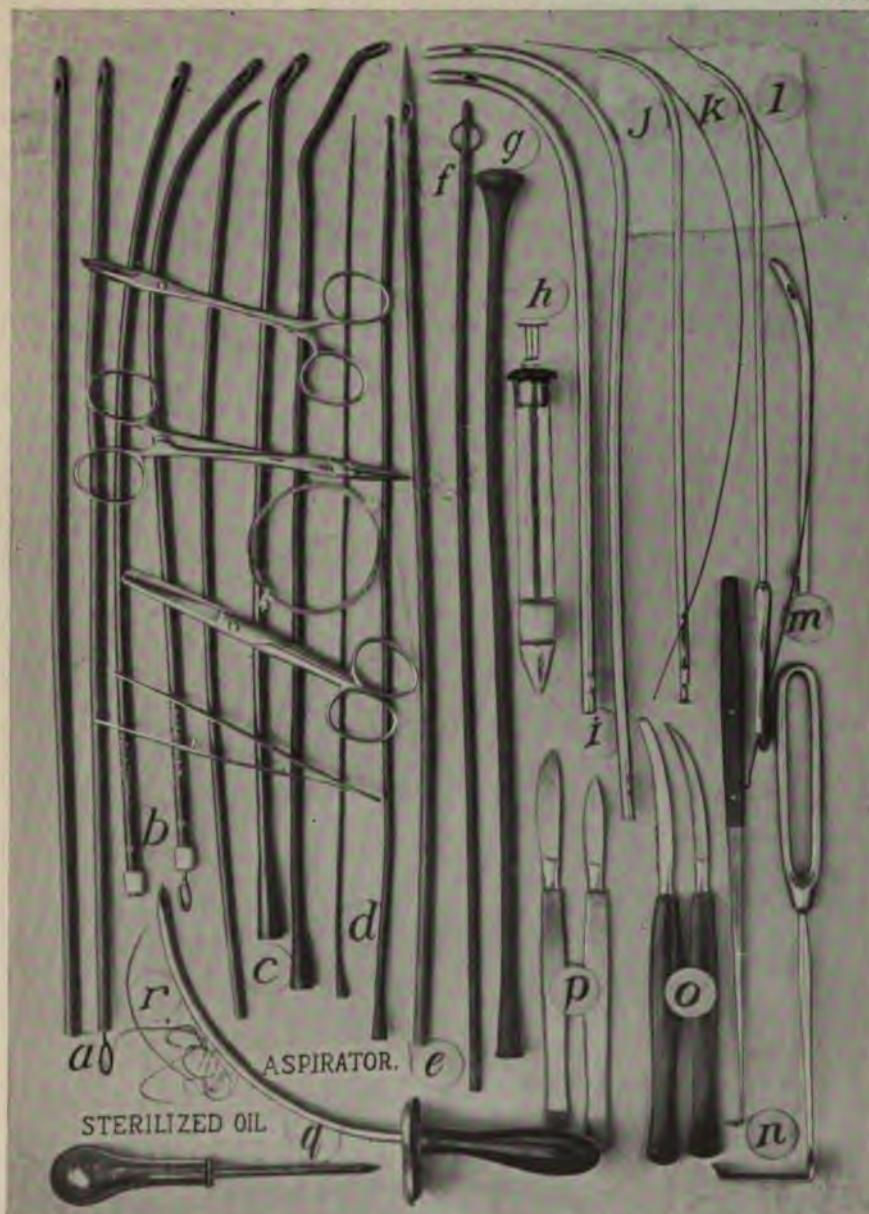
FIG. 1482.—Instruments employed in the treatment of retention of urine.

a. Conical soft-rubber catheters, one with stylet. *b.* Conical gum-elastic catheters, one with stylet. *c.* Flexible single- and double-elbowed catheters. *d.* Olive-pointed flexible catheters. *e.* Pointed soft-rubber catheter. *f.* Holt's self-retaining catheter. *g.* Jacobs's self-retaining catheter for bladder drainage. *h.* Small glass syringe. *i.* Ordinary and prostatic silver catheters. *j.* Tunneled catheter and whalebone guide. *k.* Tunneled sound and whalebone guide. *l.* Wiper. *m.* Female catheter. *n.* Tenaculum and blunt retractor. *o.* Curved probe- and sharp-pointed bistouries. *p.* Scalpels. *q.* Straight and curved tractors and cannulæ. *r.* Long needle and traction loops. Forcipressure, scissors, forceps, wipers, small sponges, sponge holders, abundant gauze, sutures, ligatures.

86

The Retention from Stricture.—If the obstruction be due to stricture, and it is permeable, catheterism will effect ready relief. If it be impossible to introduce an ordinary catheter, even of a small size, recourse must then be had to filiform bougies (Fig. 1483) or whalebone guides (Figs. 1484 and 1485). The patient is placed in the dorsal position, and sometimes local anæsthesia is employed. If general anæsthesia be necessary, it is advisable to relieve a much-distended bladder of some portion of the fluid by suprapubic aspiration (page 1116) to avoid the danger of rupture during the struggles of the patient. If one be not entirely familiar with the use of the whalebone guides and the tunneled catheter (Figs. 1485 and 1487), neither local nor general anæsthesia is advisable, as then the patient's sensations can not be consulted, and great harm might arise from their use.

FIG. 1486.—The introduction of whalebone guides. *a.* Guide bent upward. *b.* Guide in lacuna. *c.* Numerous guides in urethra, one passing stricture.

The Introduction of Whalebone Guides.— After cleansing the meatus and glans (page 1303), the urethra is forcibly filled with sterilized oil by means of a syringe (Fig. 1482, *h*), and the end of the penis grasped to retain the fluid, leaving sufficient room at the meatus for the introduction of the whalebone guide. A guide is carefully introduced, and if its point becomes engaged in a lacuna (Fig. 1486, *b*), it is withdrawn a little and again carried onward with a rotary motion. If it enter a false passage, or is arrested by a stricture it is allowed to remain there, while another guide is passed by its side, and so on until four or six, or even more, are contained in the canal (*c*), some of which have the spiral and others the straight or elbowed end foremost. Each one is then taken separately and pressed onward, with or without the rotatory motion, always remembering to use no force, else the small points may pierce the mucous membrane of the urethra, or enter and perforate Cowper's ducts. As soon as all the side openings are closed by the extremities of the guides, one guide will be found to have entered the stricture (*c*), and, with a little coaxing, will pass into the bladder, which is known by the painless ease with which it can be moved in and out. The others are

FIG. 1487.—Gouley's tunneled sound and whalebone guide.

then withdrawn, and the end of the one remaining is passed through the eye of a tunneled sound (Figs. 1482, *k*, and 1487), or, what is better, the tunneled catheter (Figs. 1485 and 1482, *j*). The guide serves to direct the passage of the instrument into the bladder, which should be done cautiously, as the guide may be cut by the eye of the instrument, causing it to double and direct the end of the catheter astray. When the instrument is in the bladder

Fig. 1488.—Filiform bougie tied in.

urine flows freely, and the beak can be turned from side to side around the long axis of the stem. After the requisite amount of urine is withdrawn, a tunneled sound of larger size may be passed in a similar manner as the tunneled catheter, after which the guide can be taken out and an ordinary steel sound of proper size carefully introduced to insure a channel of sufficient capacity to admit the ready entrance of an instrument thereafter.

The Comments.—A whalebone guide may bend, turn upon itself (Fig. 1486, *a*), and become arrested. It is important to know that the bladder should not be entirely emptied of its contents, but that only a sufficient amount of urine should be drawn to afford complete relief from all pain and tension. If it be completely emptied, its walls will collapse from want of support, causing congestion of the lining, and in all probability the catheter will be required at one or more succeeding attempts at urination. But if a third or half of the contents be withdrawn, the bladder is likely to expel its contents properly when the occasion next requires. A failure to enter the bladder finally calls for perineal section (page 1480). A filiform instrument can be fastened in place for the purpose of dilatation of a stricture by harnessing the instrument to the glans by means of a soft silk thread carried around the corona.

Retention from Enlarged Prostate.—In retention from this cause prompt relief should not be limited by palliative procrastination. In the majority of instances the invaginated (Fig. 1726) single- or double-elbowed flexible catheter (Fig. 1482, *c*) can be quite readily passed; failing with this, the

Fig. 1489.—The temporary fastening in place of a flexible catheter.

introduction of the soft-rubber instrument, with the ordinary stylet (Fig. 1482, *a*) to maintain the needed form and rigidity, can be tried at different curves. The silver prostate catheters (Fig. 1482, *i*) and the malleable one of block tin can be employed, but always with infinite

care. The form of the latter can be easily changed by bending to meet the demands of a devious entrance to the bladder, and has repeatedly been used by the writer with gratifying results. However, its liability to bend and break when used with unwise manipulative force should be recognized and heeded. In rare instances the whalebone guide and long curved tunneled catheter may solve the difficulty, but the danger from their immoderate use is not to be underestimated. The too pointed extremity and improper curve of the latter unfit it for common use. The length of time employed in these manipulations should be limited to ten or fifteen minutes, and the vigor of the effort should be of a conservative character. At the best, some bleeding will follow in many instances, regardless of the instrument employed. If entrance to the bladder be gained only after considerable diffi-
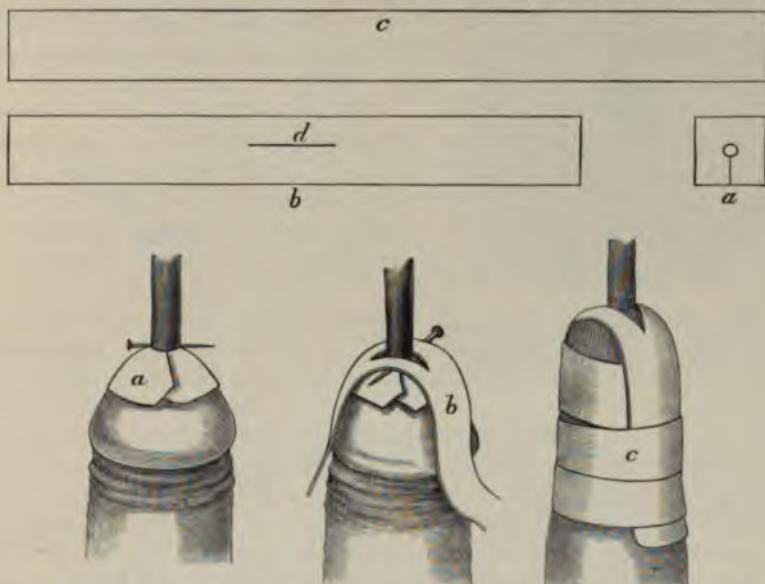
Fig. 1490.—The fastening of a catheter in place, Dittel's method. *a.* Adhesive plaster collar. *b.* Retention plaster holding pin. *c.* Strip binding others in position. *d.* Slit for passage of catheters.

culty, the catheter should be fastened in place by one of several methods (Fig. 1489) and permitted to remain for a time, and, if withdrawn, be quickly followed by a flexible one, which is permitted to remain at least for forty-eight hours undisturbed. Continuous catheterism can be practiced for two or three weeks if frequent cleansing of the urethra and the catheter be employed (Fig. 1490). The tape holding the instrument in place may be pinned to a bandage passed around the body. If the surgeon fail to enter the bladder, he should then resort to suprapubic aspiration, or puncture, or to perineal section.

Puncturing of the Bladder.—Puncturing the bladder is done to relieve the organ from overdistention. The puncture can be made either above or below the pubes, and through the rectum. It may be performed by direct

incision with the ordinary curved trocar, and by aspiration, the latter being the safer and often the more satisfactory way.

The Anatomical Points.—The anatomical points are considered under Suprapubic Lithotomy (page 1416).

Suprapubic Puncture.—"Suprapubic puncture is the operation of choice," says Alexander, "in cases of retention due to enlarged prostate in which catheterization is impossible. It may also be advantageously employed in cases of retention due to old induration from stricture, especially when the latter is of traumatic origin and associated with false passages, and in which catheterization is impossible. In such cases the choice must be made between perineal section without a guide and suprapubic puncture combined with retrograde catheterization, to be at once followed by perineal section."

The Operation by Direct Incision (Suprapubic Cystotomy).—As Alexander truly says, "The operation may be performed under local cocain anæsthesia in cases where a general anæsthetic is inadvisable. The pubis is shaved and the skin scrubbed and disinfected. An incision about an inch and a half long is made in the middle line, beginning at the symphysis pubis (Fig. 1491). The skin and fasciæ are divided down to the linea alba. The rectus muscles are carefully separated and held apart by small retractors. If the bladder be distended, the prevesical fascia and fat will appear at the bottom of the wound. They are divided and drawn to the upper part of the wound, and a round, sharp bistoury is then plunged into the bladder at the lowest part of the anterior wall, and an incision large enough to admit a 25 F. catheter is made as the knife is withdrawn. The catheter is then introduced and fixed in place, and the wound closed up to the catheter."

Fig. 1491.—The operation by suprapubic incision. The peritoneal reflexion seen at the upper angle of the incision.

The Operation by Aspiration.—The contents of the bladder can be removed by aspiration by introducing the aspirating needle into the organ above the pubes at the point indicated for the passage of a trocar (Fig. 1492). This, however, is a temporary measure only. The same can be said of tapping per rectum. These expedients are important, as they enable the surgeon to gain time for the performance of external perineal urethrotomy or otherwise to afford relief. If aspiration be practiced with aseptic precautions, it may be performed two or three times daily for quite as many weeks in cases not afflicted with pronounced cystitis with no unfavorable outcome. The suction force should be continued during the withdrawal of the needle to prevent urine from infecting the line of puncture at that time.

The Operation with a Trocar.—After thorough preparation, as in the
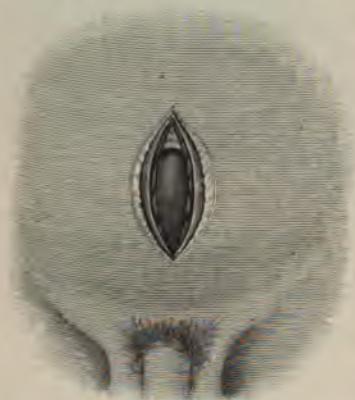
preceding instances, place the patient on the back; outline the distended bladder by percussion; explore the tumor with a hypodermic needle if a doubt exists as to its nature (Fig. 1492). Select a small straight or curved trocar, the latter being the better; make the skin tense at a point about an inch above the pubis, and push the trocar through the median line with its convexity upward. An initiatory incision through the skin is often made with a sharp knife, which permits the easier entrance of the trocar. A preliminary injection of cocain may relieve the patient of the pain caused by the introduction of the trocar.

Puncture under the Pubes.—If the bladder be small and shrunken behind the pubes, or the prostate be too large to admit of the rectal puncture, the penis can be pulled downward, and a small, curved trocar, with the concavity upward, passed just beneath the arch of the pubis into the viscus.

Puncture through the Rectum.—In puncturing by this route it is important to empty the lower bowel and thoroughly cleanse the rectum; place the patient in the lithotomy position, and introduce the left index finger

Fig. 1492.—Suprapubic puncture of the bladder with trocar, the fingers indicating seat of puncture. Eye of cannula is indicated.

into the rectum; locate the vesiculæ seminales and base of the prostate; place the end of the finger between the former, allowing it to rest upon the base of the prostate; carry along the palmar surface of the finger a curved trocar, and push into the bladder just above the base of the prostate; withdraw the trocar, leaving the cannula in place, tying it in position, or substituting a soft catheter passed through the cannula before removal.

The almost universal practice of employing aspiration, and the superiority of this method over that of the trocar, has quite consigned the latter, along with rectal puncture, to an honorable remembrance only.

The Remarks.—Puncture of the bladder is performed to relieve the organ from overdistention when for any reason external perineal urethrot-

omy is impossible or not immediately desirable. Puncture above the pubes is devoid of operative danger unless a mistake is made in the diagnosis. The escape of urine should be regulated the same as in catheterism, when practicable, and for a similar (page 1113) reason. Sometimes the relief of overdistention will permit later the introduction of a catheter through the proper channel.

Rupture of the Bladder.—Rupture of the bladder may be either extraperitoneal (15 per cent) or intraperitoneal (85 per cent). Rupture occurs most frequently at the posterior surface, the urine escaping into the peritoneal cavity causing peritonitis. When the rupture occurs anteriorly the urine infiltrates the tissues of the walls of the abdomen and perinæum, causing extensive cellulitis and diffuse suppuration. The history of injury, the presence of bloody urine, and the failure to recover by catheterism a definite amount of injected sterile fluid are among the decisive symptoms of rupture.

If the rupture be intraperitoneal, the abdomen should be opened in the median line upward from the pubes six or eight inches, the intestines held aside with sterile pads, and the vesical opening sought for. When found, it can be satisfactorily closed by either Cushing's (Fig. 910), Halsted's (Fig. 919), or the Czerny-Lembert (Fig. 915) suture in the same manner as for intestinal wounds. Purse-string sutures are employed (Fig. 1617). The blood clots and urine are then carefully removed from the peritoneal cavity by sponging and irrigation with hot normal saline solution. A moderate distention of the bladder with aseptic fluid will test the integrity of the sewing. If the opening be not disclosed by inspection through the abdominal incision, the leakage following the injection into the bladder of a moderate amount of saline or of Thiersch's fluid will reveal the site of rupture. Careful cleansing and drainage, etc., attended with continuous catheterism for several days, and confinement in bed, are demanded. If the wound be large, irregular, and lacerated, the line of sewing is less secure, and the demand for drainage is the more positive and prolonged.

If the Rupture be Extraperitoneal.—The presence of an extraperitoneal rupture may be told by the area of abdominal extravasation before operation, or be determined only after the performance of laparotomy. The seat of rupture is established through a suprapubic approach to the bladder, and further exposed by properly directed external incisions. The opening is closed as before, and the wound thoroughly drained with gauze. The sewing in cases of extravasation from rupture is comparatively insecure on account of the absence of the serosa and the presence of established infection. The abdominal wound is closed up to the point of leaving ample room for the escape from the prevesical space of drainage agents just above the pubis.

The Remarks.—The introduction into the rectum of the finger, followed by pressure upward against the base of the bladder during injection of the test fluid, will enable the surgeon to estimate correctly the degree of vesical distention attending the act. The rupture is usually located posteriorly midway between the summit and base of the organ. If the rupture be low down, the use of the inflated rectal bag will bring the parts under better

command.　Division of the parietal peritonæum at either side of the bladder (MacCormac) may be needed to effect the proper exposure. *MacCormac* advises catheterism at suitable intervals with a soft-rubber instrument in lieu of the continuous plan of treatment.　The injection of air or hydrogen gas into the bladder for diagnostic purposes is practiced much less than that of water.　In other respects there is comparatively little to express in favor of their use.　If the rupture be small and inflammation around it have already taken place, the fluid may not escape into the peritoneal cavity at first, requiring repeated and often large injections for the purpose.　Free manipulation of the bladder through the rectum with the finger, or pressure upon it by a distended Barnes dilator, may develop the presence of rupture.　The writer once met with a case with limited extravasation so incased by adhesions behind the bladder that when distended it resembled the outlines of an uninjured organ.　The opening was small, and no doubt the end of the catheter conveying the fluid passed into it.　If one be satisfied that no infection remains in the peritoneal cavity the abdominal wound may be closed at once; if otherwise, suitable drainage should be provided. If the rupture be near the base, the need of the frequent and possibly continual use of the catheter for a few days is emphasized.　In prevesical rupture free drainage of the bladder and of the infiltrated tissues should be had.　Continuous drainage of the bladder by a catheter should be superseded by suprapubic siphon drainage (page 1321 *et seq.*), or drainage by a perineal cystotomy in case of doubtful efficiency or the occurrence of complicating objections.

The Results.—If the operation be done promptly, and the urine be sterile, the prognosis is good.　If the case be delayed, or the urine be infective, the prognosis is correspondingly bad.

The death rate from intraperitoneal rupture with operation is about 40 per cent, in the extraperitoneal about 38 per cent.　During the last fifteen years the death rate has been reduced fully 50 per cent.

Cystotomy.—Cystotomy consists in opening the bladder through the perinæum usually, or above the pubes.　These operations are called respectively perineal cystotomy and suprapubic cystotomy.　It is practiced not infrequently for the relief of obstruction due to enlarged prostate, for inveterate cystitis, and to afford digital examination and ocular inspection of the cavity of the bladder, and for the removal of morbid formations.

Perineal Cystotomy.—Perineal cystotomy consists in opening into the bladder through the median line of the perinæum, as in the median operation for stone (page 1412).

The anatomical points are noted under Lithotomy (page 1401).

The Operation.—Place the patient on the back, evacuate the rectum, introduce a grooved staff into the bladder, and with a sharp knife make an incision in the median line about two inches in length, terminating about half an inch in front of the anus; by repeated and successively shortened applications of the knife—carefully avoiding the bulb—the staff is reached, and the membranous urethra opened backward to the apex of the prostate. Introduce a small probe into the bladder by way of the groove in the staff, withdraw the staff cautiously, carefully introduce the index finger into the

bladder along the probe as a guide, and distend the neck of the bladder sufficiently to cause the urine to escape as fast as it flows into the bladder. The prostatic structure must be well dilated, else it will soon return to its normal condition and require a repetition of the dilating process. The prostate may be incised on either one or both sides, as in lateral and bilateral lithotomy, to maintain the patency of the opening for any length of time. Cystotomy is now quite frequently performed as an ultimate expedient in obstinate cystitis in both sexes. In the female the incision is made into the bladder through the vagina.

Suprapubic Cystotomy.—The bladder is opened above the pubis by a transverse (Fig. 1101) or vertical incision (usually the latter) for various purposes, notably for removal of stone and prostatectomy (page 1333).

The Results.—The operation of cystotomy alone implies but little danger to the patient. However, when done in the presence of disease of the bladder or kidneys, the final outlook is much less promising, and can be well judged by the results in operation for these conditions respectively.

Cystotomy for Tumors.—Tumors can be removed from the bladder by the perineal or the suprapubic route. The *perineal route* is the better one when the growth is near to the vesical orifice, especially if the perinæum be not deep and complicated by enlarged prostate. Even in such cases as these the advantage gained by dependent drainage can not be underestimated, since it lessens the death rate, promotes the comfort, and contributes to the recovery of the patient. After cystotomy is performed and the neck of the bladder is dilated, forceps with serrated blades and distinctive curves (Fig. 1493, *i, j, k, l*) are introduced into the bladder, opened, the tumor seized and twisted away—not pulled, as forcible traction is highly objectionable. Repeated applications of the forceps, directed by the finger in the bladder, are made until the tumor is finally removed. Unusual bleeding is controlled by hot-water irrigation, direct pressure, etc. Suitable drainage of the bladder (Fig. 1494) should follow the operation for some days, after which the urine is permitted to resume the natural channel. *Gouley, Chismore,* and others have removed polypoid growths through the urethra by means of a lithotrite.

The Comments.—Suprapubic pressure to secure control of the tumor may cause the forceps to seize the bladder walls with obvious outcome. Polypoid growths of all kinds can thus promptly be removed, but sessile ones of extensive growth are not amenable to this treatment.

The suprapubic route for the removal of vesical tumors affords the opportunity of good observation, intelligent manipulation, and scientific technique. The anatomical points are stated under Suprapubic Lithotomy (page 1197).

The Operation.—After thorough cleansing of the abdominal wall, perinæum, mucous and cutaneous surfaces of the genitals, and of the bladder and rectum, place the patient on the back with the hips and shoulders raised to relax the abdominal wall; introduce the rectal bag (Figs. 1612, 1613, and 1614) above the sphincters, and distend it with six or eight ounces of fluid; inject into the bladder eight or ten ounces in the adult, and in the child about half of this amount; make an incision from the pubis upward in the

PAQUELIN'S CAUTERY.

ELECTRIC LIGHT.
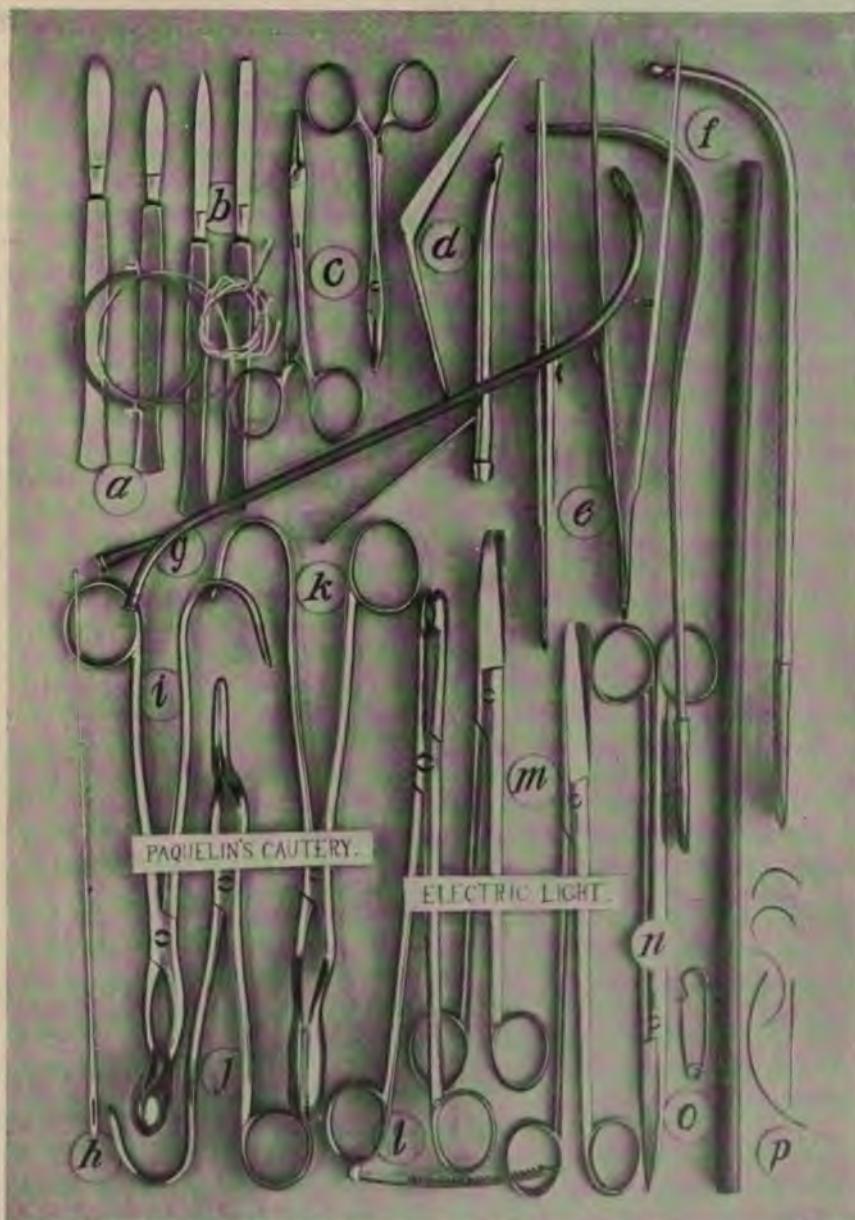
FIG. 1493.—Instruments employed in cystotomy and treatment of tumors of the bladder.

a. Scalpels. b. Bistouries. c. Forcipressure. d. Teale's gorget and Brown's grooved catheter director for primary incision. e. Long forceps. f. Grooved staffs. g. Double-current catheter. h. Long silver probe. i. j, k. Thompson's tumor forceps. l. Wyeth's forceps. m, n. Long, straight, blunt-pointed, and curved blunt- and sharp-pointed scissors. o. Safety pin and perineal drainage tube. p. Assorted needles. A female silver catheter, elbowed and straight rubber catheters, scoops, rongeur, blunt and hooked retractors, sponge holders, tenaculum, wipers, ligatures, traction loops, and tampons should be at hand.

median line three or four inches in length; separate the tissues in the
median line, going through the fascia that bounds the prevesical space in
front, exposing the prevesical fat; pass the finger behind the pubis, hook up
and draw upward the prevesical fat along with the peritonæum, thus expos-
ing the bladder; draw apart the borders of the wound with retractors or
traction sutures; smear the wound with iodoformized vaseline to prevent
infection; introduce at each side of the median line of the bladder, through
the muscular coat in front, a traction suture; thrust through the bladder in
the median line, half an inch below the upper border of the pubis, a bistoury,
and cut upward sufficiently to admit the index finger; introduce traction
sutures through each border of the wound of the bladder, and draw the
bladder open as the incision is extended upward, duplicating the sutures
if need be, or using retractors instead; place the patient in Trendelenburg's
position (Fig. 62, vol. i) and remove the rectal bag; cleanse the bladder by
irrigation and sponges, and proceed to inspect the cavity with the electric
light; incise the bladder transversely if additional room be needed. After
exposure the growth is removed by forceps (Fig. 1493), cutting, cautery
excision, etc., as seems to best suit the demands of the case.

   The Remarks.—Tearing of the tissues should be carefully avoided.
The muscular fibers should be separated and fascia divided, not torn.
Bleeding points are promptly secured throughout the operation, and antici-
pated by clamping before division, when feasible. It is wiser to carefully
divide the prevesical fascia after drawing up the peritoneal fold than to
tear it asunder, as then infiltration and sloughing are encouraged. In lieu
of the traction suture a tenaculum can be inserted transversely into the wall
of the bladder in the median line just below the peritoneal fold (Figs.
1491 and 1101, a), or at the seat of the upper limit of the proposed incision,
which when drawn upward supports the wall of the bladder and protects
the peritonæum from injury at the same time. The incision into the blad-
der should be made away from avoidable vessels, and the mucous membrane
quickly divided, otherwise it may be pushed off the bladder wall and remain
uncut. The finger is not introduced until the borders of the bladder wound
are under the control of silk loops or of forceps, unless it be done to hook
the bladder forward and hold it while the other restraining influences are
being applied. The borders of the wound should be carefully treated in
every instance. It may be advisable in rare instances in disease of the blad-
der to sew the lips of the visceral wound to those of the abdominal incision.

   Trendelenburg advises that a slightly convex transverse incision four
inches long be made above the pubis (Fig. 1101) with the convexity down-
ward, in cases where the bladder is small and distensible. The prevesical
space and the bladder are opened through this incision without risk of dam-
aging the integrity of the peritonæum.

   Langenbeck proposed a subpubic route through an inverted ʌ-shaped
incision (Fig. 1101), the arms of which correspond to the course of the rami
of the pubis.

   Helferich proposed a subperiosteal resection of the pubis through a trans-
verse incision made along its upper border, to render the bladder more
accessible. Symphysiotomy has been proposed for the same purpose.

Infiltrating tumors of the wall of the bladder are readily treated, unless they implicate the base of the organ and its important associations. *If the tumor* involve the muscular coat only, the peritonæum corresponding to the growth is dissected off and away from the tumor, the tumor removed, and the muscular wound closed with sutures, without involvement of the peritoneal cavity. If the peritonæum be involved, then the entire thickness of the wall must be removed, which is done best by the use of a clamp and through and through sewing with catgut, if the physical aspects of the tumor will permit of such a course. The implication of the ureteral region of the bladder has a much more serious aspect, not only on account of the ureters themselves, and the necessity of disposing of their discharges, but also of the greater difficulty of repair, and the contiguity of important structures. However, the base of the bladder, and, in fact, the entire organ has been removed successfully (page 1370). So far as the final disposition of the ureters is concerned, *Clado*, according to White and Martin, adopts the following conclusions: "Leaving the ureter open in the wound after extirpation of a neoplasm is extremely dangerous. Implantation into the rectum is almost invariably fatal. Implantation into the colon (page 1058 *et seq.*) is more successful. Implantation into the parietal wound (page 1063) is sometimes a matter of necessity. Implantation into the vesical cavity (page 1054) and anastomosis with the ureter of the opposite side (page 1065) are the two operations which give the greatest promise of a definite recovery."

Albarran summarizes the general treatment of malignant tumors of the bladder as follows: "The patient should be placed in the Trendelenburg position and the neoplasm subjected to an examination. If the tumor is sessile, if no enlarged lymph nodes are found, and if the patient is in good condition, resection of the bladder wall is indicated. This resection is easily performed if the tumor is placed above the opening of the ureters, since it is then unusually accessible, enough room being secured by incision through the attachments of the recti muscles. When the tumor is placed posteriorly in a bladder which is naturally deep seated, or above the ureteral orifice, or behind the anterior wall of the bladder marked by the pubic symphysis, partial resection of the symphysis or symphysiotomy may be required. Resection of the tumor is easiest when it is situated upon the upper portion of the bladder where the peritonæum can be readily stripped back. After this stripping, the tumor, with a portion of the healthy bladder wall, is cut away with scissors and the wound is sutured. If the tumor is placed above the ureters posteriorly it may be circumscribed by an incision through the mucous membrane and resected from within outward, no effort being made to strip the peritonæum first. If the tumor is placed about the orifice of the ureter, the latter should be catheterized, should then be exposed by cutting through the lateral wall of the bladder, and should be freed and implanted into the healthy wall of the viscus. If this operation is impossible, the wound made through the bladder wall for the purpose of exposing the ureter should be closed, and the urine escaping through the ureteral catheter should be examined carefully. If the urine is clear, showing that the kidney is not infected, the catheter should be

withdrawn and the ureter should be ligated, divided below the ligature, and suitably implanted (page 1053 *et seq.*). If the urine escaping through the catheter is turbid, showing admixture of pus, the ureter should be divided and fixed to the abdominal wall. Whatever procedure is employed for the purpose of giving more room, the bladder should be closed completely, a permanent catheter should be introduced, and the prevesical space should be packed with iodoform gauze. Total resection of the bladder is indicated only in the case of multiple epitheliomata which have not yet extended beyond the muscular wall."

After removal of the tumor, arrest the hæmorrhage and drain the bladder through the suprapubic opening, through the urethra, or by perineal urethrotomy. Chromicized catgut sutures carried down to but not through the mucous membrane, and placed about a quarter of an inch apart, should be employed, so as to hug closely the drainage tubes (page 1322). Close the abdominal wound with silkworm-gut sutures, leaving a point at the lower end unclosed, through which a strip of gauze is passed to drain the prevesical space. The epipubic notch is a sure guide to the median line below, and can be located through a small incision of the superficial tissues in all cases.

The Precautions.—The prevesical adipose tissue should be treated kindly to prevent suppuration, urinary infiltration, etc. The author has practiced a free smearing of the wound with iodoformized vaseline in such cases with satisfactory results. Extended glandular enlargement contraindicates extensive operation on the bladder for removal of malignant disease. When the urine is sterile, the bladder healthy, the wound small and closed completely, permanent closure of the vesical and abdominal wounds with continuous catheterism are indicated. If the reverse be present drainage should be provided at the seat of the wound. In all instances careful scrutiny should be exercised to detect urinary infiltration and forestall its evil effects.

The Results.—*Butlin* reports 57 cases of partial cystectomy with 16 deaths; 10 of complete, with 4 recoveries; more fatal in men than women (page 1370).

Berg [*] proposes a radical plan of procedure in cancer of the bladder that comprehends the removal of the infected lymph nodes and lymphatic vessels the same as in cancerous disease of other parts. Berg regards the operation as especially applicable to disease of the posterior wall and base of the bladder.

The Operation.—Thoroughly cleanse and shave the genital region and introduce catheters into the ureters; make an incision in the median line from the pubis upward about three inches in length; place the patient in the Trendelenburg position and pack off the small intestine with large, moist, warm compresses and cover them with dry gauze pads; divide the peritonæum of the pelvic floor straight across in line with (in female) the vesical aspect of the cervix, or (in male) the anterior aspect of Douglas's *cul-de-sac*; raise the peritonæum from off the floor of the pelvis to the bifur-

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[*] Annals of Surgery, vol. xl, September, 1904.

cation of the common iliac artery; recognize the ureter and its adherent peritonæum made distinct by the presence in the ureters of the catheters; trace the ureter downward to the bladder, carefully avoiding any injury of the vascular supply; dissect out down to the bladder the lymph nodes and vessels and the surrounding connective tissue lying along the course of the internal iliac artery; control the bleeding caused by the dissection with gauze packing; treat the opposite side in a like manner; carefully arrange the gauze packing so that incision of the bladder will not soil the wound; open the bladder in healthy tissue above the seat of the disease; wipe the cavity dry with soft sponges and cauterize the surface of the growth; excise widely the morbid part, also the ureter if diseased, and implant the severed end into the bladder independently of preceding incisions; close the wound caused by removal of the growth with two rows of sutures, i. e., continuous catgut stitch for the mucous, and silk mattress stitch for the muscular, coat; drain the pelvic floor with gauze carried (in female) into the vagina, or (in male) between the prostate and rectum through the perinæum; close the pelvic peritonæum over the gauze drainage agent and close the abdominal wound without drainage.

The Precautions.—In the dissection avoid the uterine artery in the female and the seminal vesicles in the male. Also disturb as little as is practicable the connective tissue associated with the ureters, as from this tissue the vascular supply of the ureters is largely derived. Always remove the lymph nodes, etc., before opening the bladder, to obviate infection.

The Remarks.—Actual cautery or pure carbolic acid may be applied to the growth before removal. Preparations for implantation of the ureter ought always to be at hand in this operation. No tension should be present in either intra- or extraperitoneal implantation of the ureter.

Drainage of the Bladder.—The bladder may be drained after operation, in three ways: First, by a catheter passed through the urethra and retained there; second, by a tube introduced through the perinæum; third, by a tube or tubes introduced through the suprapubic wound.

Vesical Drainage per Urethram.—This method of drainage is only applicable in cases in which drainage is required for a short time. It is rarely that the catheter can be retained more than three or four days without causing more or less serious inconvenience. Many patients can not tolerate the presence of the retained catheter. This method may be used to advantage in such cases as amputation of the penis and in certain cases of enlarged prostate in old men who have become accustomed to catheter life. In these latter cases it is sometimes useful, when the calls to micturate are frequent, to introduce a tie in or a clamp catheter at night, thereby giving the patient a chance to sleep. To be effective, the retained catheter must be carefully and accurately adjusted, and fastened securely so as to prevent slipping.

A soft-rubber catheter, size No. 12 F., with velvet eye situated as near the extremity as possible, and without a *cul-de-sac*, is sterilized by boiling, and is introduced so that the eye is just within the bladder. If the catheter is too far in the bladder it is certain to cause painful vesical contraction; if it is not introduced far enough the urine will not flow through it. If the

bladder be emptied by a catheter and a boric-acid solution be substituted for the urine, and the catheter, while being slowly withdrawn, is arrested and fastened just before the fluid ceases to flow, it will be suitably located. With aseptic care continuous catheterism may be kept up from one to three weeks with comparative comfort and no danger. However, if urethritis arise, causing much infliction, drainage of another form should be substituted. At first relief may be afforded in these cases by flushing the anterior urethra with a warm boric-acid solution. After accurate adjustment, the catheter is properly secured (Fig. 1490), and the end of the catheter or a rubber-tube attachment is submerged in a bottle or urinal, containing an antiseptic solution, placed between the patient's thighs as he lies in bed. When this method of drainage is used the catheter should be changed daily and replaced by a new one, or, if the same catheter be used again it should be resterilized by boiling. Whenever catheter drainage is used the bladder should be washed out at least once a day with a hot sterile borax solution.

Perineal Drainage.—Perineal drainage may be employed after all operations upon the bladder, prostate, and deep urethra, or in cases of severe cystitis in which it is desirable to give the bladder rest. The membranous
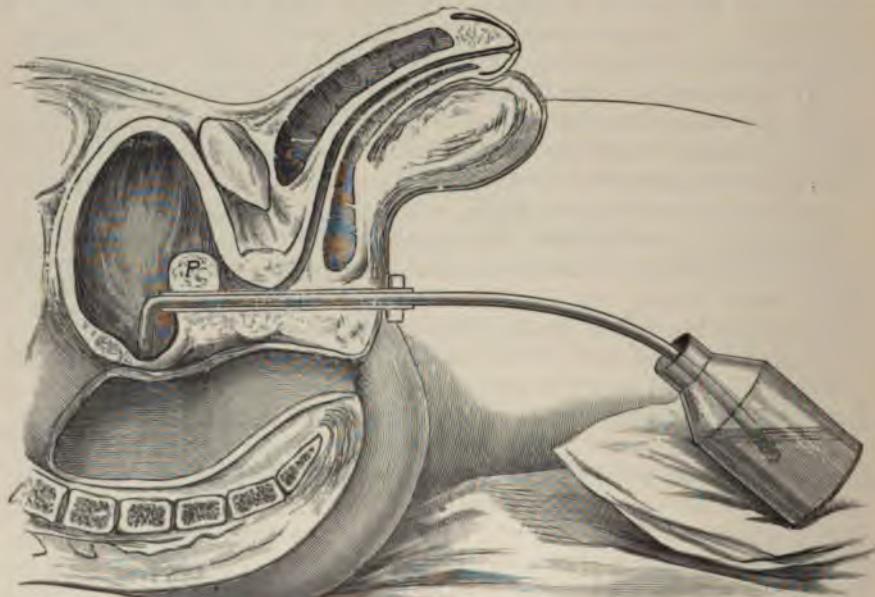
Fig. 1494.—Harrison's method of perineal drainage.   *P.* Enlarged prostate.
Antiseptic solution in bottle.

portion of the urethra having been opened through the perinæum, the finger is introduced through the prostatic urethra into the bladder. The stretching of the prostatic urethra by the finger greatly lessens the pain felt at the end of the penis experienced by cases where the drainage tube is retained. A rubber catheter, size No. 26 to 30 F., with a large eye near the end, and

without a *cul-de-sac,* and with a wide lumen, is introduced into the bladder and adjusted so that the eye is just within the bladder; the adjustment should be made with the patient's thighs on the same plane as the body. The instrument is secured in place by tapes which are tied about it as near to the perineal wound as possible, and are then brought up and secured to a waistband. A dressing of gauze pads, perforated to admit passage of the catheter, is made and secured by a T bandage. After the patient is in bed the end of the catheter is connected to a long piece of rubber tubing having a glass funnel at its extremity, and the tube and funnel having been filled with water, the latter is sunk in a vessel placed on the floor under the bed, or in it (Fig. 1494), and containing a solution of bichloride, 1 to 2,000.

The bladder can be washed out as often as necessary by disconnecting the siphon tube and injecting the fluid carefully through the catheter by means of a Politzer's bag or a carefully adjusted syringe.

The tube should be taken out every two or three days, sterilized, and re-introduced. This method of drainage is the best in most cases, and may be continued for many weeks, if necessary.

Suprapubic Drainage.—Suprapubic drainage of the bladder after suprapubic cystotomy will depend upon the condition for which it is employed and the probable time for which the tube will be retained.

In operations where there has been little hæmorrhage the bladder may be drained by a single tube. Where there is a possibility of a single tube becoming plugged, either by blood clot or by masses of muco-pus, two tubes should be employed. The tubes should be of red rubber, flexible, and about twenty inches in length; the best size is about 26 F. The vesical end of the tube should be cut obliquely, and the sharp end trimmed smooth; a large fenestrum should be cut in the side near the extremity of the tube.

When a single tube is used it is passed into the bladder so that its end nearly reaches, but does not touch, the lowest part. A safety pin is then passed through its wall at the skin level. The bladder wound is sutured with chromicized catgut up to the tube, care being taken that no stitch passes through the mucous membrane. The outer wound is then united by deep silkworm-gut sutures. The dressing consists of a pad of gauze perforated to admit the tube, and close to this another safety pin is passed through the wall of the tube; the pins prevent the tube from slipping. Gauze pads are then applied and held in place by strips of adhesive plaster. The tube is then attached to a siphon apparatus, as already described. The Dawbarn drainage apparatus is well suited for the purpose (Fig. 1499).

The Remarks.—When suprapubic drainage is used after operations upon the bladder which are likely to be followed by hæmorrhage, it is better to employ two tubes. These are adjusted in the same manner as has been described above. The siphonage appliance is attached to the lower tube and the upper one is clamped by a pinch forceps. The bladder can be washed by injecting fluid into one of the tubes, the wash flowing out of the other. Stripping of the tube with the thumb and finger may be needed to eliminate the air when the siphonage is broken.

Gibson's Method of Drainage.—*Gibson,* noting the excellent practical outcome of Kader's method of gastrostomy (page 900) in controlling the

87

opening into the stomach, applied this practice to drainage of the bladder with commendable results.

The Operation.—A rubber tube (32 F.) is passed into the bladder through a snug-fitting opening, and the bladder wall is brought closely
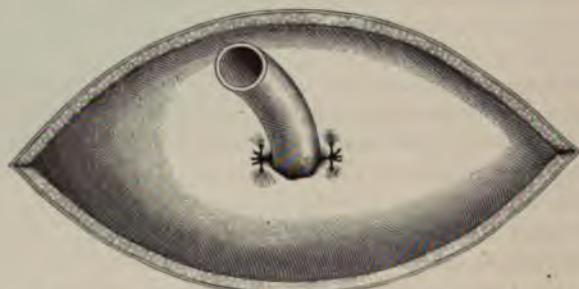
FIG. 1495.—Drainage of the bladder, Gibson's method. Tube inserted and stitches employed to diminish size of opening.

around it by passing through the wall at either side (Fig. 1495) of the tube a Lembert suture. The first of the inversion sutures are then introduced (Fig. 1496). These sutures are tied, cut short, and " a second set is applied and tied (Fig. 1497), thus increasing the depth of the burial of the tube in the wall " (Fig. 1498). The tube is then secured in place by a catgut suture connecting it with the bladder wall. The ends of the second set of sutures are left long and utilized in the closure of the abdominal
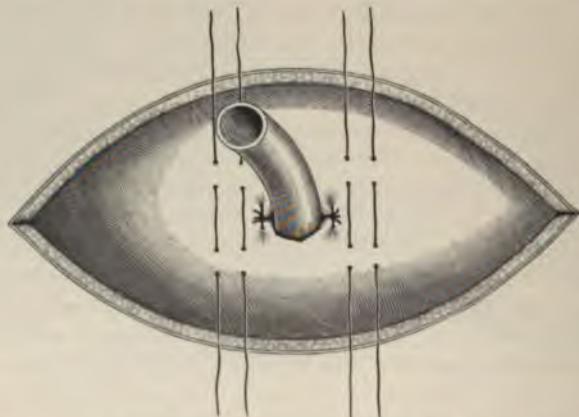
FIG. 1496.—Drainage of the bladder, Gibson's method. First set of inversion sutures in place ready for tying.

wound snugly around the tube. " Perfect drainage is effected by leading the tube into a receptacle, which need not be filled with fluid of any kind." On removal of the tube the artificial opening is guarded by the valve arrangement of the infolded bladder wall, which is readily pushed aside

by the catheter employed in relieving the bladder, without the annoyance of subsequent leakage. It appears to the writer that this simple method affords a great advance in effective bladder drainage in either acute or chronic requirement.

Dawbarn's Apparatus for Bladder Drainage.—This plan of action is based on the old principle of intermittent siphonage, an idea of respectable
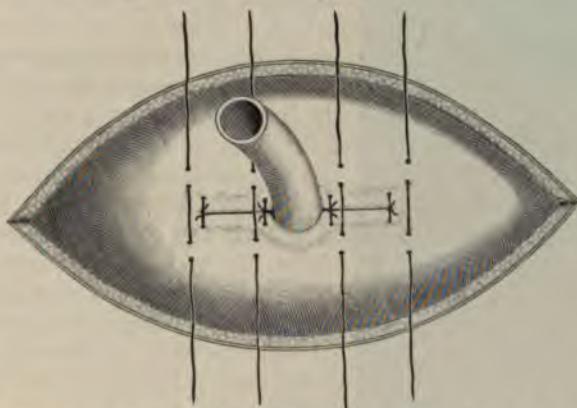
FIG. 1497.—Drainage of the bladder, Gibson's method. First set of sutures tied, second in place for tying.

age and useful employment (Fig. 1499). The following is substantially a statement, made by Dawbarn, of the apparatus:

"*d* indicates the clamp which comes with every fountain syringe. It has been removed from the end and snapped upon the side of the tube, so as almost to close it, permitting flow only drop by drop. Forcipressure may be employed instead.

"*a* indicates the joint between two or three pieces of rubber tubing. The simplest way, if one has a glass, metal, or vulcanite T-tube, is to use it in making the connection. But if not, the joint is made as follows: Cut out a circle from the side of the exit tube from the bag. Sew the end of the other tube to the edges of this small hole. Make the joint tight with rubber cement (made by dissolving gutta-percha tissue in chloroform to saturation), and strengthen the union by wrapping around it narrow strips of rubber adhesive plaster.

FIG. 1498.—Drainage of the bladder, Gibson's method. Longitudinal section, showing bladder infolded by two sets of sutures.

"*b* indicates a trap which is absolutely essential. The trap of the main exit tube, three inches across, is formed by knotting (as in the sketch) or by snapping on an elastic band around a loop of the tube.

" *e* indicates an apparatus introduced to collect urine (Fig. 1499); a small piece of glass tubing a couple of inches long is employed when the apparatus is not in use. The device operates as follows: the water trickles down from the reservoir until the trap (*b*) becomes filled; when overfilled it siphons off with a rush. This in turn makes a partial vacuum above the trap, which is filled by the drawing up of the urine in the bladder, thus forming a second siphon, causing the fluid to run freely from the bladder until it is empty.

" This process of intermittent siphonage repeats itself at regular intervals of any desired frequency. As a rule, if the flow from the reservoir be no faster than from one to two drops per second, this will suffice to prevent a bladder from overfilling. And at this rate of flow it is not necessary to replenish the bag of the fountain syringe oftener than once in several hours.

" Usually a No. 20 to 24 F. soft catheter (*c*) is carried through the suprapubic wound to the bottom of the bladder. The catheter, like a stomach tube, should have two openings below, a second opening being cut opposite the original one, thereby preventing obstruction from the sucking in of a fold of mucous membrane. At the point of escape from the bladder the tube is fastened to the dressings with a safety pin.

" Should washing out of the bladder be desired, it is easily done without disturbing the wound. Take off the clamp (*d*) and pinch the tube tightly below *a*.

Fig. 1499.—Dawbarn's apparatus for bladder drainage. *a.* Point of junction of tubes. *b.* Knot trap in main tube. *c.* Opening in end of tube. *d.* Forcipressure limiting lumen of tube. *e.* Chemist's wash bottle. *f.* External segment of rubber tubing through which catheter passes into bladder.

" The contents of the fountain syringe will then run freely into the bladder. Cease pinching below *a*, close the tube at *d*, and the fluid will run by siphonage out of the bladder into the bucket below.

" Sometimes it is desirable to know the exact amount and the appearance of urine drained away; also we may wish to analyze that urine undiluted by fluid from the reservoir.

" Then insert in a break (*e*) at any point in the tube leading from the bladder the chemist's wash bottle with its usual equipment—a tight-fitting
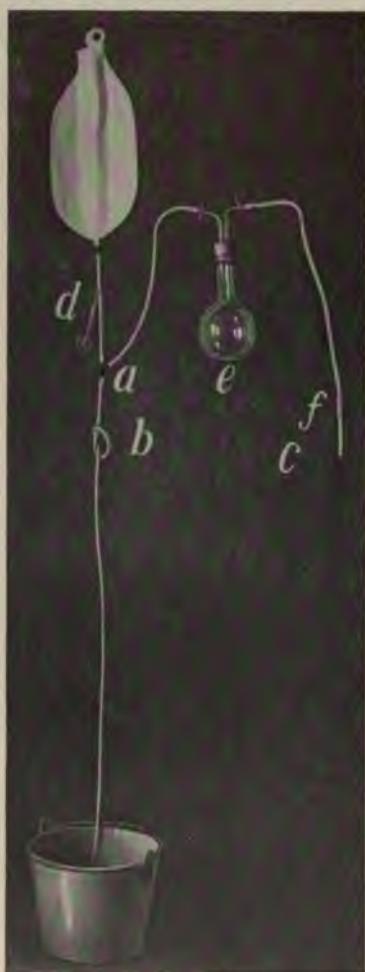
rubber stopper and two glass tubes—thus the urine can be collected and the amount and characteristics can be determined."

The Remarks.—The catheter (*c*) is passed through a brief segment (*f*) of rubber tubing, which latter just enters the bladder, and is fastened to the central tube with a stitch, and is held in place by another stitch connected to the plaster dressing of the wound. Air can pass between the tubes. If the urine be thick a larger catheter (No. 30 F.) should be employed.

Artificial Urethra in Prostatic Obstruction.—The formation of a so-called artificial urethra above the pubes in cases of obstinate prostatic obstruction is a measure of important moment, in many instances attended with septic inflammation of the bladder. After thorough attention to aseptic details directed to the seat of the operation and to the vesical cavity, cause the elevation of the bladder above the pubes by the careful employment of the rectal bag and vesical injection, as in suprapubic cystotomy (Figs. 1612, 1613, and 1614).

The Operation.—Make a vertical incision in the median line three or four inches in length through the integument and fasciæ down to the upper
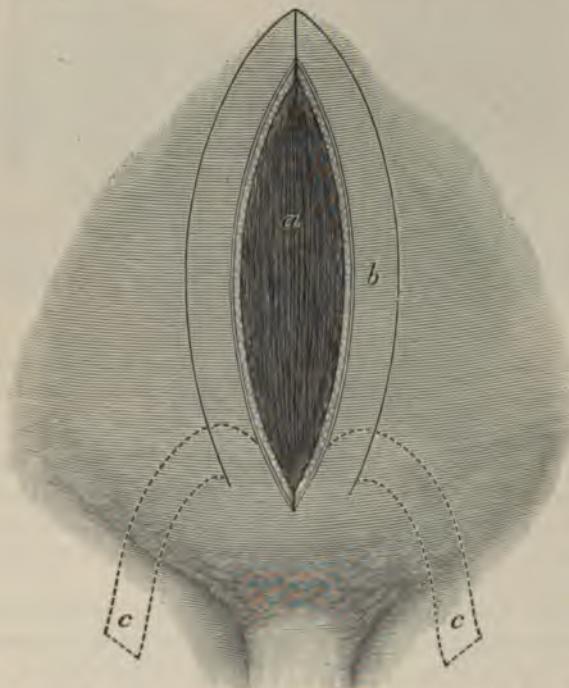
Fig. 1500.—Operation for artificial urethra, Morris's method. *a.* Aponeurosis of external oblique. *b.* Flap. *c, c.* Outlines of displaced flaps.

border of the symphysis pubis; expose and divide by a shorter incision the linea alba vertically down to the pubes; separate the recti muscles in the median line and divide the fascia transversalis for two inches in length

down to the pubis; expose the bladder by careful incision and displacement of the prevesical cellular tissue, leaving that part behind the pubes undisturbed; catch the exposed area of the bladder with a tenaculum and pull the viscus forward into the wound; open the bladder in the median line opposite the upper border of the pubes with a scalpel sufficiently to admit the index finger; introduce through the abdominal opening into the bladder a No. 10 or 12 E. soft-gum catheter; close the bladder and the abdominal wound around the catheter at the lower and the abdominal wound at the
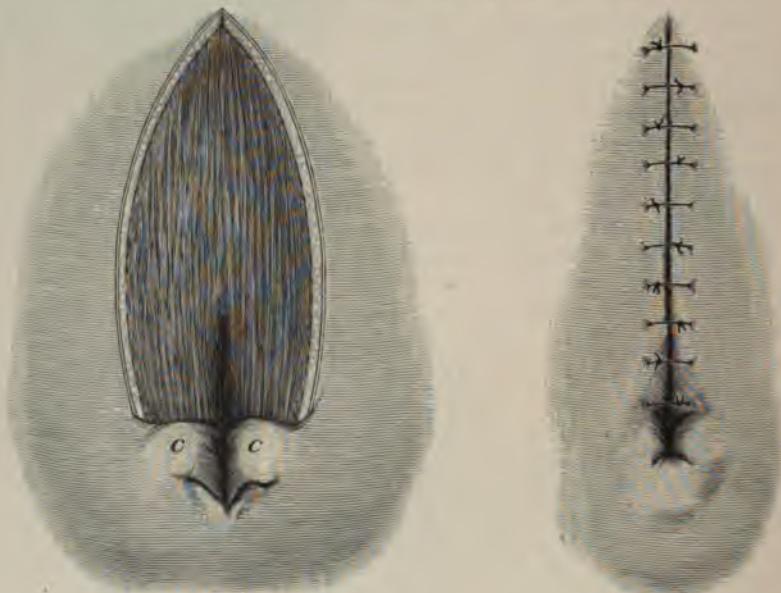
FIG. 1501.

FIG. 1502.

FIG. 1501.—Operation for artificial urethra, Morris's method. *c, c.* Flaps turned inside.
FIG. 1502.—Operation for artificial urethra, Morris's method. Wound closed, showing orifice in lower end.

upper end with sutures; pass the catheter upward against the rectus and unite over it with deep silkworm-gut sutures the borders of the wound so as to form a fistulous communication with the bladder three or four inches in length; connect the distal end of the catheter by a tube with a receptacle of aseptic fluid placed at the side of the patient.

The Comments.—If vesical tenesmus follow, the catheter should be removed and the drainage wick substituted. The urine is kept acid, absorbent cotton applied as often as needed, the patient kept in bed, and continuous urethral catheterism maintained if danger of urinary infiltration be apprehended. *McGuire* punctured the bladder, established a fistula with it, and regulated the discharge of urine by fitting to the fistula a silver plug held in place by a belt worn around the hips.

The Results.—The functional use of the sinus urethra is quite satisfactory in all respects. The intervals between the acts of micturition vary

from two to six hours, and are not attended with discomfort, and the discharge of the urine is free and pronounced. Cicatricial narrowing is sometimes excessive and objectionable.

Morris's Modification of McGuire's Operation.—*Morris* proceeded after the manner of McGuire in exposing and opening the bladder. However, he temporarily stitched the bladder to the abdominal wall while preparing and attaching to the incision in the bladder the two skin flaps that constitute the modification. A skin flap a third of an inch in width and about three inches in length, including the fat and subcutaneous tissue, is dissected from either side of the abdominal incision and remains attached below (Fig. 1500). The free ends are turned inside so as to bring their cutaneous surfaces in contact with each other, and each extremity is sutured to the mucosa of the bladder at the respective side of the incision (Fig. 1501). The retention sutures are then cut, and as the bladder recedes the cutaneous flaps are drawn into position. The upper portion of the wound is closed in the usual manner (Fig. 1502). Aristol is rubbed into the wound to lessen
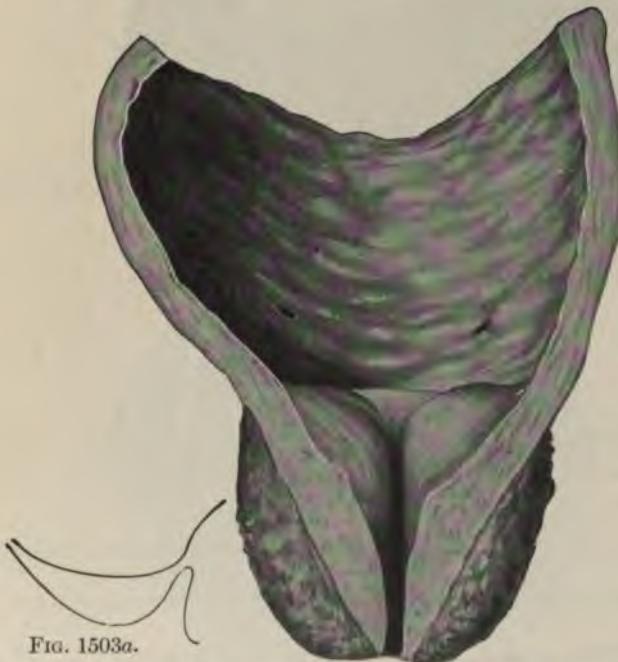
Fig. 1503a.

Fig. 1503.—Bilateral hypertrophy of the prostate without median enlargement. The sagittal section (1503a) shows the elevation of a fold of mucous membrane between the lateral lobes.

the danger of urinary infiltration, and the urine withdrawn by the drainage wick with one end in the bladder and the other lying on the abdomen.

This modification aims to establish a sinus with a cuticular lining and to secure the benefits of such a provision. *Morris* now regards it advisable to make the flaps wider. *Moullin* employed the flaps, leaving them attached

at the upper instead of the lower end in order that he might establish a larger urethra. The plan answered well at first, but soon obstruction occurred in the passage at the junction of the cutaneous and mucous structures, which was a source of much annoyance. The patient could retain the urine for three or four hours, and expel it guided away from the body by a tube placed at the orifice. *Gibson's* method of drainage bids fair to eliminate these more complicated operations from the needs of surgical technique.

Prostatectomy.—Prostatectomy is an operation devised for the removal of all or a part of the hypertrophied portion of the prostate to secure relief from the following conditions:

1. When there is complete or almost complete retention of urine due to prostatic outgrowths about the internal urethral orifice or projecting into

Fig. 1504a.

Fig. 1504.—General hypertrophy of the prostate, the median and lateral lobes forming a single mass.

The sagittal section (1504a) shows the elevation of the urethral orifice.

the prostatic urethra, making the patient entirely dependent at all times upon the use of his catheter. The consequences can not be doubtful in such cases, and operation affords the only means of averting fatal disaster.

2. When there is marked and continuous vesical irritability due to intravesical outgrowths which can not be allayed by the most careful catheterism and washing of the bladder. These patients usually suffer from frequent attacks of hæmaturia, and cystitis, when it develops, is usually severe.

3. When, in spite of careful catheterism, the amount of residual urine is steadily and surely increasing, showing a gradual failure of expulsive force in the bladder.
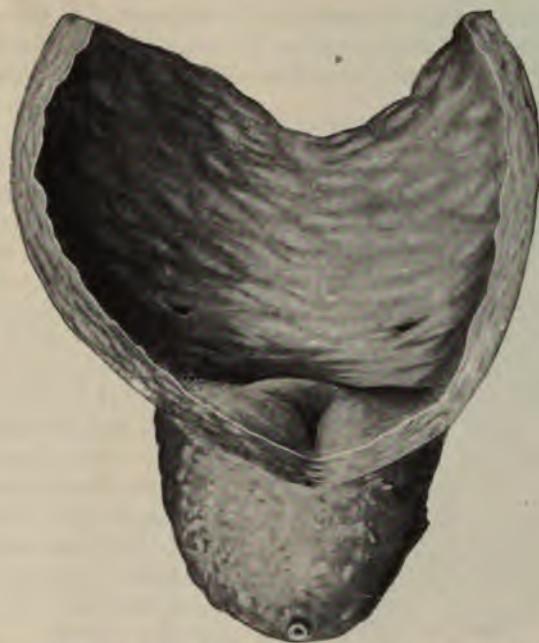
FIG. 1505.—General hypertrophy of the prostate, with relatively slight median enlargement in the form of a bar.

The sagittal section is similar to 1504a.
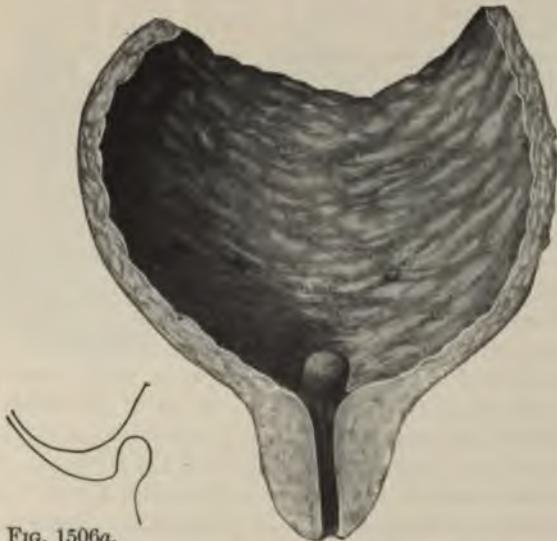
FIG. 1506a.

FIG. 1506.—Pedunculated median enlargement.

The sagittal section (1506a) shows an obstruction quite as pronounced as in 1503a and 1504a, but less lengthening, and distortion of the prostatic urethra.

4. When catheterism is becoming more and more difficult in spite of all precaution, and when it is frequently followed by hæmorrhages.

5. When catheterism, in spite of all precaution, is frequently followed by attacks of cystitis.

6. In cases of long-continued vesical inflammation which do not yield to treatment.

7. In cases in which the patients can not or will not use a catheter and take the necessary aseptic precautions to make its use of value.
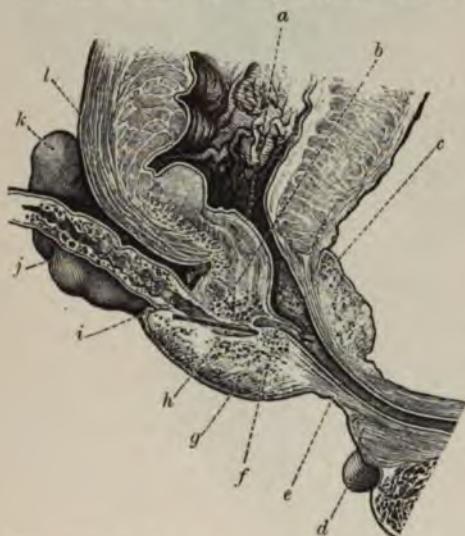
Fig. 1507.—The prostate and its associated anatomy. *a.* The uvula vesicæ. *b.* The isthmus of the prostate. *c.* The prostatic urethra. *d.* Cowper's gland. *e.* The membranous urethra. *f.* The utricle. *g.* The prostate. *h.* The ejaculatory duct with guide through opening. *i.* The union of the excretory duct and seminal vesicle. *j.* The vas deferens. *k.* The vesicula seminalis. *l.* The fundus of the bladder.

In a word, it may be stated that catheterism, with all that the term implies in the treatment of prostatic enlargement, should be employed in all cases until it fails to give relief; but that when it fails, and the integrity of the bladder and kidneys is threatened, we should resort to operative treatment before these organs have become hopelessly damaged (Alexander).

According to the present conservative view: " The best time for its performance is just as soon as palliative efforts have failed, or are manifestly impossible of execution, and *before* secondary changes in the bladder and kidneys, due to long-continued obstruction, have taken place (Thorndike)." The more radical notion contemplates operation as soon as catheter life is at hand, rather than wait and invite the sequels that often follow the continued use of the catheter under the best devised plans of prevention. In our opinion, each case should be decided upon its own merits rather than by any fixed decree. We are, however, favorable to early operation.

The anatomical points of the perinæum are considered elsewhere (page 1401), and those related to the prostate will now be briefly mentioned. The substance of the prostate is principally made up of glandular, unstriped muscular and fibrous tissues. The glandular tissue is in the lateral parts and the ducts unite and open along the floor of the urethra. The muscular fibers are circular and are continuous with similar fibers of the bladder. The fibrous portion (prostatic sheath of Thompson) forms a quite firm surrounding capsule with thin septa extending through the substance. The organ itself is surrounded by a fibrous capsule formed in part by the pelvic fascia. The prostate has a limited mobility because of its attachment to

the bladder and deep perineal and rectovesical fascia and subprostatic ligaments. Underneath and in the outer capsule is a plexus of veins best developed in the central line, and sometimes at the base and sides of the body.

The attention of the reader is called to the site, size, and relations of the prostate to the urethra and seminal vesicles as depicted in standard works of anatomy. For a practical description of the arrangements of the structure of the prostate, please consult (page 1337) the outcome of the labor of Alexander.

FIG. 1508.—The inverted "ʌ" incision (Senn). Borders united and wound drained.

It seems quite fitting at this time to say something of the gross changes of the prostate causing the afflictions calling for the various methods of relief that follow; also that apt illustrations relating to these changes be introduced as object lessons of highly practical import. The common hypertrophies of the prostate causing infliction are: 1, Decided posterior enlargement; 2, elevated internal urethral orifice; 3, obstructing middle lobe; 4, lengthened and distorted urethra.

In the first instance both the rectum and bladder are encroached upon, as can be easily known by examination. The lobes may be unequally enlarged, having an unencumbered passage between them, or the passage may be obstructed by a median lobe or fold of (Fig. 1503) mucous membrane.

FIG. 1509.—The inverted "ʌ" incision (Senn) employed in prostatectomy.

In the second instance the urethral orifice is raised above the level of the trigone because of general hypertrophy of the prostate (Fig. 1504), the presence of a third lobe, the lifting of a fold of mucous membrane at the orifice, or by inflammatory changes, thereby forming a "bar" to the escape of urine at the internal orifice.

In the third instance a "median lobe" is developed of varying shape, size, and origin; usually, however, connected (Figs. 1505 and 1506) with the

posterior commissure. Median enlargement is noted in 81 per cent of tabulated cases (Keyes). The decided and often erratic exhibitions of urinary obstruction caused by these deformities are matters of not infrequent occurrence and of urgent demand.

In the fourth instance the urethra is altered in length, size, and direction from the normal by the various prostate changes, a fact made obvious by the preceding illustrations of prostatic hypertrophy.

In this connection it is interesting and instructive in an anatomical, and especially in a practical operative sense to (Fig. 1507) recall the comparative relations of the prostate with important structures contiguous to and within its diseased grasp.

Two routes of approach to the prostate are practiced: the perineal and suprapubic routes. Two methods of procedure are advised in connection with the former route: one, *the partial method*, in which, after a perineal section, the growth can be reached with the finger, and on account of its small size,

Fig. 1510.—Keyes's tampon in suprapubic prostatectomy.

limited attachment, and accessibility, can be readily removed through the perinæum with forceps and punches. *Gouley* practiced this method with signal success before and since 1885. This class of cases is comparatively infrequent, and though temporarily relieved by the treatment without especial danger to the patient, may soon again cause renewed affliction by continued growth. The outcome of this partial method of prostatectomy emphasizes the utility of the complete methods. The other, *the complete method*, is applied to the organ above or below the pubis, as suits the nature of the case and the inclination and experience of the operator.

The Incisions.—The variety of the incisions selected for the exposure of the prostate in the perinæum should contemplate minimum hæmorrhage, suitable exposure of the organ, ready manipulation and good drainage, also the incision should be familiar to the operator himself. The position of the patient during exposure of the prostate in the perinæum is a matter of great practical importance. The attitude exhibited in Fig. 1523 is adopted by many operators, and certainly places the organ in such relation with the surface of the perinæum as to afford greater facility of action and observation than with a less flexed state of the trunk and limbs. As will be noted, each operator quoted describes the incision of his own plan of technique. However, modifications are in order to meet the purposes of special indications as they appear. The inverted λ (Figs. 1508 and 1509), the median (Fig. 1607), the lateral, and the curved bilateral lithotomy incisions are standard methods of practice.

The suprapubic incision relates to exposure of the bladder, as in cystotomy, also those for special purposes that will appear later.

Suprapubic Prostatectomy (McGill).—Shave the pubis, scrub and wash the parts thoroughly; irrigate the bladder with the boric-acid solution, leaving a considerable portion (6 to 10 ounces) of the fluid in the viscus; introduce the rectal bag above the sphincters (page 1407) and distend it moderately (6 to 10 ounces).

The Operation.—Expose and open the bladder as in suprapubic cystotomy (page 1310); sew the borders of the opening to those of the abdominal wound with catgut; place the patient in the Trendelenburg position and expose the prostate to palpation and inspection by means of retractors and a strong light; incise the mucous membrane covering sessile growths, and enucleate the growths through the opening with the finger, aided by the curette or curetting forceps when required; sever pediculated tumors at the base with curved scissors and remove the growth; divide the collarlike growths into halves by cutting above and below the vesical orifice with scissors and follow by enucleation. The portion of the gland projecting into the bladder is cut in halves and each is separately enucleated and removed. Cutting should be avoided on all occasions when the same result can be accomplished by enucleation. The hæmorrhage is usually quite free, and promptly obscures the process of enucleation from observation. It is sometimes severe and may be even dangerous, requiring especial attention to prevent undue loss of blood. Hot water applied directly to the part with sponges or gauze, which are held firmly in place for a time, will usually suffice to arrest the flow. Informal packing with gauze, or the use of the gauze tampon devised by Keyes (Fig. 1510), or that of Cabot (Fig. 1511) may be required to arrest hæmorrhage. *Keyes* thus describes his tampon: " The tampon is made of bichloride gauze. A square of four thicknesses of gauze is first cut, the length of each side being about six inches.

FIG. 1511.—Cabot's tampon for suprapubic prostatectomy.

Upon this are placed eight thicknesses of gauze cut square, each side measuring four inches, and upon this eight other thicknesses of gauze, also square, the sides measuring three inches. Centrally, upon the three-inch pad, a small white shirt button is tied by a stout silk ligature, transfixing the pad and tied upon the six-inch square surface. This central button also has a piece of silk attached to it, running out freely in the direction away from the three-inch surface. This is to facilitate extraction. Each of the corners of the six-inch pad is stoutly tied with a piece of silk, and the silk from each of these four corners is

knotted at its end into a double knot, while the silk running out backward
from the button is tied with a single knot, for the purpose of distinguishing
which is which when making the extraction; although practically it will be
found that they must all be made taut and pulled upon all together in order
to effect removal with the greatest ease and facility." This tampon is
applied through the suprapubic opening to the bleeding surface, and held
firmly in place by a cord attached to it and passed through a perineal
opening of the urethra and secured externally by a roll of gauze. The
tampon is rarely retained longer than twenty-four hours. The bladder is
drained through the suprapubic opening by one of the various methods of
drainage already described. Frequent and sometimes continuous irrigation
of the bladder is practiced for a few days. The construction of Cabot's
tampon is explained by the illustration.

The Comments.—Prostatectomy should not be practiced hastily, but
rather during a quiescent state of the disease, if possible, to avoid undue
hæmorrhage and reaction. It is wise in severe and offensive cases to estab-
lish preliminary drainage of the bladder for a time before attempting pros-
tatectomy, thus dividing the procedure into two stages—preliminary and
final. If the bladder be much contracted, its distention so as to appear
above the pubis may be attended with not a little danger of rupture.
However, vesical distention and peritoneal elevation are of less operative
importance than is the support given the prostate by the distended bag.
The opening into the bladder is made at the most prominent portion of the
anterior surface, and should be large enough at first to admit the index fin-
ger readily. *Fuller* exposes the prostatic structure with scissors, inserts the
fingers into the incision and enucleates the growth, while firm upward pres-
sure is made on the perinæum. Suprapubic and infrapubic drainage is
then established. He advises that the incision of the mucous membrane
covering the enlargement be made as small as is consistent with a proper
enucleation with the fingers. If the prostate be fibrous and hard, enuclea-
tion will be very difficult, if not impracticable, and cutting with biting for-
ceps must be employed instead for the removal. While a practical success
depends on the complete removal of the growth, still, the amount removed
should be measured by the demands of the case. Posterior and lateral
encroachment of the growth on the canal should be removed so as to form
a funnel-shaped orifice with a low and level urethral floor at the prostatic
opening. Drainage of the prostatic portion of the urethra is best made
through the perinæum, as suprapubic drainage is better adapted to intra-
vesical operations. A perineal incision provides not only drainage, but the
opportunity to support the prostate body during its removal. Suprapubic
entrance is not admissible for the purpose of prostatectomy when the blad-
der is contracted to a small hard sac. Hard prostates yield less to pressure
than the soft, and therefore they require less rectal distention. A suture
should be introduced at the lower angle of the abdominal wound to lessen
the possibility of urinary infiltration. Introduce the finger into the vesical
opening to see if the urethra is intact before leaving the wound. *Kümmel*
sutured the bladder and drained through the perinæum with a catheter.
Keyes in dense cases at the neck employed the rongeur for removal.

The Results.—Complete cure does not follow the operation in the majority of the cases of recovery, because of the structural changes in the bladder. Therefore, the ultimate prognosis of early operations is better than those done at a later period. Of 243 cases, 28 (11.3 per cent) died from the operation; of the fatal cases, 34 per cent died of uræmia and 8.6 per cent from sepsis. Of 53 cases, 35 (66 per cent) had complete functional restoration (Watson). *Alexander* records the following objections to the suprapubic method:

" 1. That the mucous membrane of the bladder and that of the prostatic urethra are cut through, and more or less torn and bruised.

" 2. That the hæmorrhage is frequently severe, and requires packing of the wound to control it.

" 3. Another and still more vital objection to these methods is that, after prostatic obstruction is removed, a cavity is left which is freely accessible to the urine. In this the urine collects, and, as this is often foul in the cases operated upon, there is great danger of septic infection. Nor can this cavity from which the prostate has been removed be efficiently drained. Suprapubic drainage alone is entirely inefficient, and even when perineal drainage is employed, the tube, in order properly to drain the bladder, must be placed above the level of this cavity."

Dittel's Method (*Lateral Perineal Prostatectomy*). — Dittel recommends removal of either lateral lobe of an enlarged prostate through a cuneiform incision (Fig. 1512). A catheter or sound is introduced into the bladder through the urethra, and held in place to enable the surgeon to recognize and avoid the urethra. The rectum is

FIG. 1512.—The operation of lateral prostatectomy, Dittel's method. String attached to gauze packing protruding from anus.

packed with gauze to secure its prompt recognition and consequent safety. The patient is placed on the table, the back uppermost, and body oblique for better opportunity of breathing, the legs of the patient hanging over the end. An incision is made from the tip of the coccyx, down the median line to the middle of the external sphincter, thence around the anus nearly to the rhaphe in front. The prostate is freely exposed through the incision, the capsule incised, and the enlargements are removed, leaving sufficient tissue to insure the urethra from injury. The wound is then cleansed, drained, and lightly packed. Several successful cases of this method of practice are reported, and on the whole it is entitled to favorable consideration. *Pyle* gains ready and uneventful access to the prostate through a perineal incision similar to

that employed in bilateral lithotomy (Fig. 1607, c). After division of the anal fasciæ and separation of the fibers of the levator ani muscle, the prostate is exposed and enucleated.

The Combined Method (Belfield).—The importance of the combination of perineal and suprapubic manipulation in prostatectomy was first noted by *Belfield*. However, to *Nicoll* belongs the credit of maintaining the integrity of the mucous membrane of the bladder and urethra, and thus preserving the perineal wound from vesical infection.

The Operation.—Suprapubic cystotomy (page 1310) is first performed. The wall of the bladder is secured to the skin by five sutures—one at the lower angle—the mucous membrane is thoroughly cleansed, and the bladder cavity is partly filled with carbolic solution (one part in two hundred). The patient is then placed in the lithotomy position, and a sound or bougie is passed into the bladder and given to an assistant. With the left forefinger in the rectum, *an incision is made in the perineal rhaphe and gradually deepened* without penetrating the urethra or the bladder until the apex of the prostate is reached. The rectum is carefully separated from the posterior surface of the prostate, and a vertical incision is made through the posterior and inferior part of the prostatic capsule. The capsule is gradually separated from the gland at either side by means of a periosteal elevator or a like blunt instrument. The assistant meantime is pressing the prostate down into the perineal wound with his fingers, introduced into the bladder through the suprapubic opening. (If sufficient room for the isolation of the prostate is not afforded by the median perineal wound, additional room may be obtained by supplementing the median incision by a lateral one, curved outward and backward, beginning at the posterior end of the median cut and curved outward and backward to a point between the anus and the posterior part of the tuber ischium, nearer the former than to the latter. This incision may be made at one or both sides.) All bleeding points having been secured, the surgeon, after carefully washing his left index finger in a carbolic solution, puts it and the middle finger of the left hand into the bladder through the suprapubic wound, and, while pressing the prostate down into the perineal wound, removes through the perinæum, with the fingers of the right hand, the entire prostate, or as much of it as he deems necessary. A sufficient amount should be removed to relieve the neck of the bladder from pressure, and permit the bringing down of the neck to a level with the post-prostatic pouch at the base of the bladder. One judges of the amount to be removed by manipulating the parts between the fingers of the two hands. If the prostatic tissue proves to be tougher and more resistant than usual, the fingers of the right hand may be supplemented by the careful use of a blunt periosteal elevator, and even by Volkmann's spoon. During the entire operation neither the bladder nor the urethra is opened, except as the former is involved by the suprapubic incision. After enucleation is completed, the instrument is withdrawn from the bladder and a large-eyed, short-beaked metal catheter (like a lithotrity evacuating catheter), or a large gum-elastic catheter coudé is introduced and tied in place. The perineal wound is douched with a weak carbolic solution, carefully dried with gauze or sponges, and firmly stuffed with

iodoform gauze. The five stitches in the suprapubic wound are cut, removed, and the bladder is permitted to drop from the abdominal wall.

The after-treatment consists mainly in douching the bladder daily through the suprapubic wound with boracic fluid or a weak solution of carbolic acid, which escapes through the catheter. The iodoform packing is changed every second or third day for a fortnight and then discontinued and the wound allowed to close. The suprapubic wound is dressed with a pad of sublimated gauze, and begins to close about this time. The douching then may be discontinued.

The comparative advantages of this method of prostatectomy appear to be the following: *a*. The hæmorrhage is much less. This is what *a priori* might be expected. The prostatic plexus of veins lies on the surface of the prostate, and is therefore chiefly removed along with the capsule. Furthermore, the plexus is chiefly located at the anterior and lateral aspects of the organ. In approaching the prostate on the posterior and inferior surfaces but few veins are encountered. *b*. The infiltration of freshly wounded tissues by the putrid and septic urine is avoided. In adequate removal of the body and lateral lobes a large gaping cavity remains. In the suprapubic operation no thoroughly efficient means of draining this cavity is known. The depth of the cavity in these cases is such that it can not be properly drained through the penis, and the fluid remaining behind is liable to decompose, which can not occur in this method of operation. *c*. The operation insures adequate removal of the obstructing prostatic tissue, thereby avoiding a chief source of failure to give relief peculiar to the perineal and suprapubic operations. *d*. The preservation intact of the bladder wall insures less risk of tearing the deep urethra, and therefore chiefly obviates the occurrence of the serious complications mentioned above. With a sound in the urethra and the fingers in the bladder there can, with care, be little chance of removing any of the bladder or urethral wall along with the prostatic tissue. *e*. The absence of a perineal tube permits the patient to sit from the first without inconvenience.

The Remarks.—In the instances of median lobe involvement, *Nicoll* advises that the removal of this portion be omitted for eight or ten days, or until the urine is aseptic and the perineal wound is covered with granulation, thus avoiding infiltration.

The Combined Method (*Alexander*).—The writer desires to acknowledge his obligations to Dr. Alexander for his kindness in furnishing the following statement, which is quoted in full:

"The object of this method is to remove those portions of the enlarged prostate which cause obstruction, with as little injury to the urethra and bladder as possible. It is based upon the following *anatomical facts*, which have been demonstrated by the writer: 1. The prostatic urethra may be divided surgically into two parts, the one lying above the openings of the seminal ducts (vesical portion), the other lying below the seminal ducts (urethral portion) (Fig. 1514). The walls of *the vesical portion* of the prostatic urethra are comparatively thick, and from this portion of the urethra the prostate may be easily removed without injury to the mucous membrane. The walls of *the urethral portion* of the prostatic urethra are

88

much thinner and depend very largely for their support upon the prostatic tissue which surrounds the canal. 2. From the central *fibrous portion* of the prostate, which lies behind the urethra, there extend laterally outward

FIG. 1513.—Transverse section of enlarged prostate immediately behind openings of seminal ducts. *a, a.* Enlarged anterior parts of lateral lobes (can be enucleated). *b.* Enlarged posterior part of lateral lobes (left after enucleation). + Upper wall of urethra, urethral opening appearing as a vertical slit, with the vera montanum below. (From Alexander's collection.)

strong trabeculæ to the fibrous capsule of the gland. These trabeculæ divide the lateral lobes into two parts—viz., 1, a portion lying in front of these trabeculæ, and lying at the side of the urethra; this is the only portion of the lateral lobe which by its enlargement causes obstruction to urination (Fig. 1515); 2, a portion lying below or behind these trabeculæ—that is, behind or below the urethra and behind and below the seminal ducts—never is by

FIG. 1514.—Longitudinal section of enlarged prostate and part of posterior wall of bladder. *a.* Enlarged anterior part of left lateral lobe (can be enucleated). *b.* Enlarged posterior part of left lateral lobe (left after enucleation). *c.* Seminal duct. *d.* Posterior wall of bladder. + + Line of prostatic urethra. (From Alexander's collection.)

its enlargement a cause of obstruction to urination (Fig. 1516). The portion of the lateral lobe which causes obstruction can be enucleated *en masse*, leaving the posterior portion of the lateral lobe and the capsule intact. The fibrous trabeculæ mentioned above form the line of cleavage between the anterior and posterior portions of the lateral lobes.

"*The Preparation of the Patient.*—The patient is prepared as for any major surgical operation. It is important, when possible, to devote a few days before the operation to an attempt to diminish infection of the bladder by careful catheterism and washing, and by the internal administration of full doses of urotropin. The patient being etherized the bladder is emptied and is then distended with a sterile salt solution, from eight to ten ounces being sufficient in most cases to bring the organ well above the pubes.

"*The Operation.*—*The bladder is exposed in the space of Retzius by a vertical incision between the recti muscles;* two traction sutures are intro-

Fig. 1515.—Longitudinal section of enlarged prostate and part of posterior wall of bladder. *a.* Moderate intra-urethral projection of left lateral lobe. *b.* Enlargement of the posterior part of the left lateral lobe. *c.* Seminal duct. *d.* Part of left wall of bladder. *m.* Enlarged middle lobe projecting upward into bladder, causing a crescentic-shaped urethral orifice (may be enucleated). (From Alexander's collection.)

duced through its anterior walls. Between these sutures an opening is made into the bladder large enough to permit the operator to pass his finger. The condition of the bladder and the intravesical projections of the prostate can now be thoroughly examined by digital exploration. The edges of the bladder wound are then united to the skin by a single temporary stitch on each side. The suprapubic opening is now covered with gauze, and the patient is placed in the lithotomy posture. A broad, median-grooved staff is passed into the bladder and held by an assistant. The membranous urethra is opened by *a free median perineal incision, cutting through the floor of this portion of the urethra from just behind the bulb to the apex of the prostate.* The operator introduces his finger into the

wound, and as the staff is withdrawn the finger is passed through the prostatic urethra into the bladder for the purpose of dilating the canal. The operator now again washes and disinfects his hands, if they have been soiled. He then passes the forefinger of his left hand through the suprapubic wound into the bladder, and presses the prostate downward into the perinæum. The forefinger of his right hand is introduced through the perineal wound into the urethral part of the prostatic urethra and begins the process of enucleation. This is performed as follows: The operator feels in the lateral wall of the prostatic urethra for a prominence due to the enlargement of one of the lateral lobes, and breaks through the mucous membrane immediately in front of this prominence. As soon as this is done the finger passes between the anterior and posterior portions of the lateral lobe in the line of cleavage formed by the fibrous trabeculæ spoken of above. The obstructing portion of the lateral lobe is easily separated on its lateral and posterior surfaces from the posterior part of the prostate and its capsule. It is then separated from the mucous membrane at the vesical neck and from the upper portion of the prostatic urethra; during this part of the operation the mass to be enucleated may be seized with forceps passed into the perineal wound and drawn down into the perinæum. The finger in the bladder may be passed into the urethra during this procedure, and prevents tearing the mucous membrane. Having removed the obstructing growth from one lateral lobe, a similar procedure is done upon the other side if necessary. When a so-called middle-lobe enlargement exists, this can be removed by pressing it down from above into the cavity formed by the removal of the lateral lobes, when it can be easily removed in the same manner. The only part of the urethra torn is that in front of the opening of the seminal ducts. After removal of all the obstructing portions, the wound and bladder are flushed with a hot saline solution; hæmorrhage is controlled by pressure; a large catheter, about 30 F., with thick walls, is introduced into the bladder through the perinæum and a rubber drainage tube with a single eye near the end is inserted into the bladder through the suprapubic tube. The bladder is then closed about this tube in the manner recommended by Gibson (page 1322), the perineal tube is retained in place by tapes fastened to a waist band, and the bladder is drained through the perineal tube by siphon (pages 1320 and 1324). The after-treatment consists in daily washing the bladder. The upper tube is removed on the fourth day and the lower tube at the end of one week. Both wounds have usually healed by the end of five weeks. The advantages we have claimed for this method are: 1, the entire obstructing portions of the prostate are thoroughly removed through a perineal opening without injury to the mucous membrane of the bladder, or of the prostatic urethra above the opening of the seminal duct; 2, hæmorrhage is rarely a serious complication; 3, the most efficient and thorough drainage of the bladder is secured; 4, the time required by practiced hands to perform the operation is comparatively short; 5, the best conditions are left for a return of complete voluntary urination.

" *The Dangers of the Operation.*—Dangers of the operation are: 1, suppression of urine in those cases in which there is advanced renal disease; 2,

ACETYLENE LIGHT

INSTRUMENTS EMPLOYED IN PERINEAL PROSTATECTOMY.

FIG. 1516.—*a.* Syme's partly dilated tractor, stem clamped with forceps, also the tractor guide. *b.* Syme's tractor with guide introduced. *c.* Periosteotome for enucleation purposes. *d.* Young's tractor with opened blades. *e.* Needles. *f.* Scalpels. *g.* Blunt retractor. *h.* Grooved staff. *i. j.* Thumb-forceps. *k.* Curved sharp-pointed and straight blunt-pointed scissors. *l.* Gorget. Albarran, Lydston, and others have devised prostatic tractors. *For instruments employed in other methods of prostatectomy, see* FIG. 1314.

hæmorrhage. Hæmorrhage is rarely serious, and can always be controlled by packing the perineal wound with gauze about the drainage tube; 3, injury to the rectum. This may occur at the time that the obstructing portions of the prostate are detached from the anterior portion of the urethra. It is, however, necessary only to remember this danger to avoid it.

"*The Results.*—The results of the operation in our hands have been good, considering the very bad condition of most of the patients operated upon. The following is a summary of the writer's cases: 31 cases, 3 deaths, 1 due to sepsis; 1 due to uræmia; 1 due to sepsis and uræmia. One partial success: the patient emptied his bladder completely, but had, at last reports, a small rectal fistula, resulting from a tear into the rectum during operation; 27 successful cases, in which the vesical function was restored, the patients emptying their bladders completely."

Many modifications have been advised and practiced with the idea of avoiding the suprapubic cystotomy element of the combined method. Such as drawing the prostate downward by means of the fingers passed into the
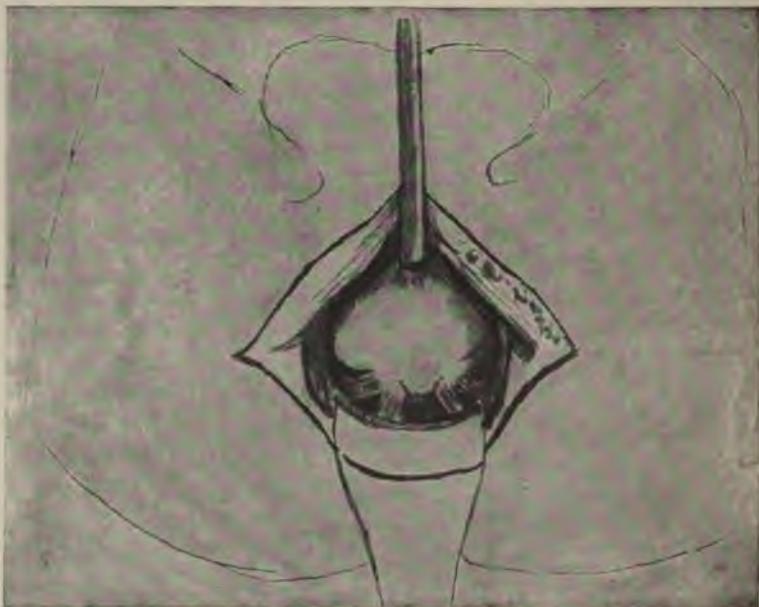
Fig. 1517.—Operation of perineal prostatectomy, tractor introduced, posterior surface exposed. Proust's method.

rectum (Celsus). Downward pressure above the pubes (Thompson) or made through an incision at that point (Bryson) not entering the bladder. *Johnson* made a small opening just above the pubis into the space of Retzius (Figs. 1491 and 583, *e*, vol. i), through which the finger was introduced, carried down to and caused to press upon the prostate while the enucleation was successfully performed through the perineal incision. It is evident that this plan is best suited to small and thin patients. *Mynter* reports

a case of enucleation accomplished with comparative ease and practical success upon a large, stout patient (two hundred and forty pounds) in the following manner: The posterior extremity of the usual longitudinal incision was extended backward in a curved manner so as to correspond to the ante-
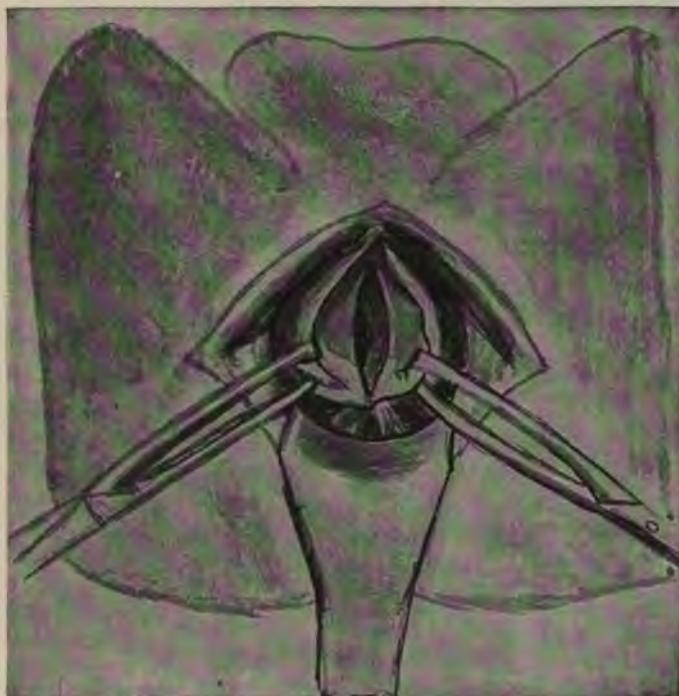
FIG. 1518.—The operation of perineal prostatectomy, capsule and prostatic urethra opened.   Proust's method.

rior half of the circumference of the anus. The curved flaps were reflected outward and prostate exposed to view. A grooved staff was then introduced into the urethra to afford a better outline of the canal in the prostate. A median incision was made into the posterior part of the prostate without opening the urethra, through which wound the enlarged lateral and middle lobes were easily enucleated with the finger while manual pressure from above behind the symphysis pubis was made on the prostate. In this instance the pronounced borders of the grooved staff contributed to rupture of the urethra during enucleation. Venous oozing from the prostate characterized this case for some hours after operation. Suprapubic and perineal drainage is then established.

Perineal Prostatectomy.—Perineal prostatectomy at the present time is in the ascendancy, and seems likely not only to enlarge the field of operation itself, but also to become the operative measure of choice. *Watson* *

* Annals of Surgery, June, 1904.

most happily has lately divided the technique of this operation into the following essentials: 1. The free exposure of the prostate. 2. Making the prostate accessible and holding it in a fixed position during removal. 3. Avoiding injury of the urinary sphincters, of the rectum, of the urethra, and ejaculatory ducts. 4. Avoiding hæmorrhage.

The Free Exposure of the Prostate.—The curved transverse (Fig. 1528), the inverted ∧ and inverted ∧ incisions (Figs. 1508 and 1509) afford full exposure and free opportunity for drainage. They are, however, attended with freer bleeding than the median incision for apparent reasons. After exposure of the membranous urethra free the rectum from it and from the prostate by transverse division of the tendinous center and by blunt dissection with the fingers between the prostate and the rectum, exposing by this means, and by aid of retractors, the posterior surface of the prostate body (Fig. 1517).

Making the Prostate Accessible and holding it in Fixed Position during Removal.—Numerous tractors have been devised to meet the requirements
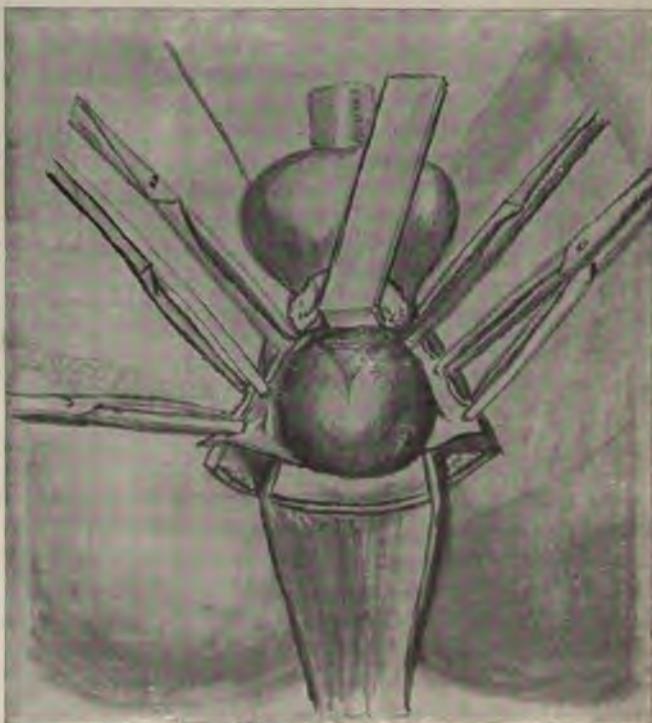
Fig. 1519.—Operation of perineal prostatectomy, capsule separated and turned back from front and posterior parts of gland, borders held by forceps preparatory to removal. Albarran's method.

of this, the second essential (Fig. 1516). Some operators regard the finger as the best tractor because of its sensibility and adaptability to these parts. *Proust* introduces his tractor and exposes the posterior surface of the

prostate (Fig. 1517), isolates, ligatures, and cuts across the upper ends of the ejaculatory ducts, and the accompanying vessels; cuts away also part of the sheath of the posterior surface of the prostate; splits by a median incision through the posterior surface of the organ, the prostate and the prostatic urethra (Fig. 1518); passes the finger into the prostatic urethra as a guide, preventing injury of the urethra during enucleation of each of the lobes in turn; enucleates the inner portions, first cutting with

Fig. 1520.—Operation of perineal prostatectomy, prostatic urethra divided, removal of gland begun. Albarran's method.

scissors their attachments to the urethra, separating the outer portions from the sheath by blunt dissection.

Albarran does not ligature the vessels or the ducts. He splits the prostate and the prostatic urethra in the median line posteriorly. He introduces his forefinger and begins the enucleation by separating the outer capsule of the gland from the proper one (inner) along the line of incision just mentioned, first with scissors, then with the fingers, as he proceeds toward the outer lateral aspects of the gland, first on one side and then on the other, until he has cleared about half or a little more of the gland from its outer sheath (Fig. 1519); then he frees the gland with scissors from the urethra (Fig. 1520) until he has separated it for about half of its length, where he cuts across and removes the freed anterior half of the gland. This enables him to easily reach the farthest ends of the two lobes with his finger tip pushed on into the bladder, and to draw each of the remaining parts of the gland well down into the wound by the finger employed as a tractor. He then frees the rest of the gland from the sheath, taking it away in one or more portions, as seems most convenient. The middle lobe is removed by splitting the floor of the prostatic urethra and enucleating the upper portion with the fingers, dividing the lower end with scissors. When the pros-

tatic urethra is much enlarged and boggy, he resects it longitudinally and sutures the cut edges together. *Young* makes a decided attempt to save the ejaculatory ducts. He introduces his tractor, makes an incision at either side of the median line through the capsule (Fig. 1521), enucleates with a blunt dissector (Fig. 1522), holding and guiding the gland during dissection, and finally removing it with forceps peculiar to himself. *Rydygier* exposes the prostate through a median incision of its capsule and frees the lobes by blunt dissection, except at the parts lying contiguous to the prostatic urethra, which parts are clamped in the long axis of that tube and cut off with scissors outside of the clamps, thus leaving small portions of the gland connected with the urethra at either side. By this course, neither the urethra nor ejaculatory ducts are involved in the removal of the gland.

FIG. 1521.—Operation of perineal prostatectomy, tractor in place and in action, posterior surface of prostate exposed, lateral incisions in capsule outside of ejaculatory ducts. Young's method.

The Avoidance of Hæmorrhage. — Since the vascularity of the prostate is largely within the outer capsule, the maintaining of its integrity so far as possible and the avoiding of injury to associated vessels by careful use of cutting instruments, and liberal employment of blunt dissection, reduces the danger of hæmorrhage and of injury to the velum to a minimum.

The General Precautions.—Conduct the operation under thorough asepsis, cleansing the rectum thoroughly before beginning and plugging it high up if necessary, to prevent invasion from above of intestinal contents. The interchange of a finger from rectum to wound should be avoided, and when done thorough cleansing of the digit should precede the act. Ample exposure of the gland should go before the operation and free drainage follow it. Avoid hæmorrhage by injuring as little as possible the outer sheath in exposing the gland and by enucleating the latter by going between

the two sheaths. Avoid splitting the inner sheath, for bleeding and confusion follow enucleation under these circumstances. Since the outer sheath varies in thickness as a whole and also in places, exercise caution, as in instances of thin sheaths the bladder and urethra are readily invaded. During separation of prostate from rectum keep the index finger in the latter as a guide to prevent injury. For the same reason avoid the use of sharp instruments when possible, practicing blunt dissection instead, and carefully shunning downward pressure on the bowel in all instances; vigorous manipulation, slipping of instruments, and the withdrawal of a large mass through a small perineal opening or a portion not detached from the urethra, each may cause rupture of the urethral wall. Arrest bleeding by packing with gauze, keep the wound thoroughly cleansed. When possible, a cystoscopic examination should precede operation on the prostate.

The General Remarks.—The perineal incision selected should conform to the size of the gland, the presumptive difficulties of the operation, and the need for drainage. *Watson* regards downward traction on the prostate by two fingers in the rectum or by one passed through the urethra into the
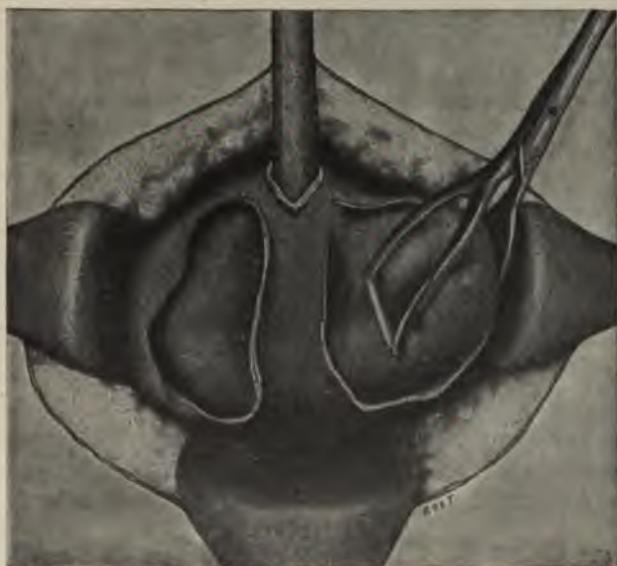
FIG. 1522.—Operation of perineal prostatectomy, enucleation of lobes, forceps in position. Young's method.

bladder as being quite sufficient for fixation purposes during enucleation in all except fat subjects. Great traction by special agents during removal of the distal part of the gland may cause tearing of the superimposed membrane. A transverse suprapubic incision may be employed instead of the vertical.

Morcellement should be practiced when the gland is so adherent to the sheath as to incur the danger of wounding the venous places of the sheath by effort of enucleation.

Parker Syms regards early operation as essential to the best interests of the patient. He does not believe in allowing the patients to continue catheter life, since he regards prostatectomy to be far safer.

Syms urges the importance of proper posture for the patient—lithotomy position, elevated pelvis with extreme flexion of the thighs (Fig. 1523). Through a median-line incision he opens the membranous urethra on a Syms staff and divides it back to the tip of the prostate. He then irrigates the bladder, dilates the prostatic urethra with the index finger, and introduces the collapsed rubber tractor (Fig. 1516, *b*) well into the bladder. The bulb of the tractor is then dilated by forcing into it, with a piston syringe, two and a half ounces of water, and the stem is clamped to prevent

Fig. 1523.—Perineal prostatectomy. Patient in exaggerated lithotomy position.

the escape of the fluid. Firm traction is now made on the tube to draw down and fix the neck of the bladder and prostate, and the tube is then carried over the perinæum and firmly held by an assistant. The fibrous sheath is now opened (Fig. 1524), and the enucleation performed with the fingers with ease and rapidity. The floor of the prostatic urethra is frequently split, which act does not prejudice the final result in Syms's experience. A drainage tube is introduced into the bladder through the perinæum, stitched in place, and the wound carefully packed with gauze about the tube.

The After-treatment.—The gauze is removed at the end of twelve to twenty-four hours. The tube is removed at the end of twenty-four to seventy-two hours. The patient is allowed to be up when the tube is removed. Syms no longer feels that the passage of a sound is necessary as a routine. Bladder function is soon restored, and complete healing should take place in from three to five weeks. The patient should be practically well at the end of two weeks. If cystitis has been prolonged, it may require careful after-treatment.

The Results.—Syms reports 35 operations with 2 deaths. The ages ranged from fifty to eighty years.

Complete and final cure from any method of operation should not be too confidently expected, but much relief and even practical cure happens in very many cases. It is quite evident that the ideal method of practice is yet to be established, also that the many important novel suggestions of practical utility frequently presented by thoughtful, skillful operators may be regarded as an earnest of an early and final success. Enough, however, is al-

FIG. 1524.—Perineal prostatectomy, Parker Syms's method. Tractor in place, sheath of prostate incised.

ready known to enable one to exercise wise discretion in the adoption of the method to fit the case. Careful study of cases before operation, attended with recorded reasons for special change in technique, followed by full statements of the immediate and final results of operative effort, will hasten ultimate conclusions.

The General Results.—Of 530 cases operated on by the perineal route, 33 (6.2 per cent) died from the operation. Of the fatalities, 35 per cent were due to uræmia and 17.8 per cent to sepsis. Of 145 cases, 87 (60 per cent) resulted in complete functional restoration (Watson). *Treves* quotes *Belfield* as follows: " Dr. Belfield gives the mortality of prostatectomy as 13 per cent, that of the perineal operation as 9 per cent, and of the suprapubic as 16 per cent. He gives the table on the following page:

RESTORATION OF VOLUNTARY URINATION.	Cases.	Successes.	Failures.	Deaths.
By perineal incision	41	17	7	4
By suprapubic incision	88	29	12	12
By combined incisions.	4	3	0	1
	133	49	19	17

" The discrepancy in the totals of the second and third columns depends upon the fact that, in estimating the result of the operation, the author has omitted all cases in which the history after operation is imperfect."

Desnos, in 22 cases of his own, reports 2 deaths (with aggravated symptoms), 4 not improved, and 15 improved and cured.

Castration, operations on the vasa deferentia, and ligature of the iliac arteries are each practiced to a greater or lesser extent for the cure and relief of prostate hypertrophy. The technique of these various operations can be found under the proper headings, and the results only will be given at this time. In 1893 * *White* formally announced to the profession his belief in castration for relief from the afflictions of prostatic hypertrophy. Since that time many operations of this nature have been done, some of doubtful result, others premature, and many ill-judged, as will necessarily happen in novel proposals. However, sufficiently trustworthy results are now before us to establish the fact that castration should be regarded as one of the proper methods of treatment in selected cases. The sentimental objection will no doubt lead to delay that will lessen the benefit that otherwise might be experienced. Castration is regarded now less favorably than formerly because of the disappointment following the practice, also because of the great advance in the beneficial outcome of prostatectomy.

Fenwick regards double castration of value in the following conditions: 1, in reducing bulky overgrowth of the lateral lobes of the prostate; it may be found that the small, tough, fibrous median or lateral vesical outgrowths will be better removed by suprapubic prostatectomy; 2, in controlling the distress and danger of an inflamed, senile, enlarged prostate; 3, in lessening the frequency or difficulty of introducing the catheter in advanced or confirmed catheter life; 4, in avoiding the mechanical difficulty of crushing a post-prostatic or a post-trigonal stone by leveling the base of the bladder, thus rendering the operation of litholapaxy feasible in a condition in which before it was impracticable; 5, in reducing chronic cystitis and recurrent phosphatic calculus in cases of confirmed catheter life.

The Results.—The death rate of operation is reported, 5 to 10 per cent in selected cases; permanently improved, 71 per cent; return of bladder contractility, 66 per cent; cystitis relieved, 52 per cent. Of 210 cases of castration for relief of prostatic hypertrophy, 34 (16.2 per cent) died from the operation (Watson).

Vasectomy (*Albarran*).—The exposure of the cord as it escapes from the external ring, and in its course to the testis, followed by ligature or sec-

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* Transactions of the American Surgical Association, 1893.

tion of vas, or division of the nerves, or ligature of the arteries of the testicle, is quite an easy matter (page 1226). The vas deferens is recognized by its pearly, firm structure. It is located normally behind the testicle and posteriorly in the spermatic cord.

The Results.—Of 252 cases, 21 (8.3 per cent) died from the operation. In mild cases and in those who refuse castration, vasectomy may be employed. The immediate danger is less than in castration and slightly greater than in the Bottini operations, but the ultimate outcome is not as good as in either.

Ligature of the internal iliac arteries (*Bier*) has been practiced by Meyer and others, but not with that degree of success that justifies the substitution of this measure for either of the preceding plans of treatment. An occasional early apparent success of an unusual measure is unfortunately often very misleading.

The Galvano-cautery Method (*Bottini*).—*Bottini* introduced to the profession the application of galvano-cautery for treatment of prostatic obstruction. Bottini's instrument has been much improved by Freudenberg (Fig. 1525). Before the operation the characteristics of the tumor should be determined by means of the cystoscope, and urotropin should be given for two or three days before the procedure. Immediately before operation wash out the bladder with a solution of boric acid, leaving in the organ about four ounces. Observe strict asepsis in all of the details of the measure. Just before using the instrument test it in all respects, noting if it be in complete order.

The Operation.—Place the patient on the back and anæsthetize with chloroform if there be no objection to its use; introduce the instrument, tightly closed, slowly into the urethra and carry it carefully over the obstruction into the bladder; turn the beak downward and hook it snugly against the prostate by making traction on the handle; introduce the finger of the left hand into the rectum and verify the correctness of the position of the instrument and keep it there during the operation; cause water to flow through the instrument for a

Fig. 1525.—Freudenberg's Bottini incisor. *a.* Cautery blade. *b.* Shaft. *c.* Grip. *d.* Irrigation tube. *e.* Screw. *f, g, h.* Electrical connection.

moment, then close the electric circuit (45 ampères), and after a few seconds slowly extrude the blade 2½ to 3½ centimeters (1 to 1½ inches) by turning the handle of the instrument (an assistant turns it); slowly return the blade to its place and open the electric circuit. This step requires a minute or two. Other · now made of less length (2½ centi-

meters) as needed in the lateral lobes or roof of the prostate in a similar manner.

The Precautions.—Ascertain that the instrument be in perfect working order before attempting its use. Local anæsthesia is apt to be inadequate for the purpose. The muscular twitching sometimes attending the giving of nitrous oxid is highly objectionable, and may be dangerous in these cases. The operator should steady the instrument, keeping it carefully in place, leaving the operation of the mechanism to an assistant. Use care in the introduction of the instrument, as the beaked end may catch on the triangular ligament (Figs. 1583 and 1584). Retention of urine, some fever, often much tenesmus and limited sloughing happen within the first few days after the operation, and permanent catheterization and perfect cleanliness should be enjoined. Carefully avoid cutting the membranous urethra, since urinary extravasation will follow the accident.

The Remarks.—Afterward a catheter is tied in the bladder for a few days, and the patient given water freely and submitted to general and local bladder medication. Only the most approved apparatus should be employed for the purpose, and the measure of the current should be ascertained and kept in view during the proceeding. The bladder is washed freely with boric-acid solution sufficiently often to remove offending substances.

Chetwood's Operation.—Chetwood divides with the cautery the prostatic obstruction through a perineal cystotomy opening with his galvano-prostatic incisor (Fig. 1526).

The Operation.—Thoroughly cleanse the bladder, anæsthetize the patient in the dorsal position, introduce the staff and perform perineal cystotomy (page 1313) ; introduce the index finger into the wound, explore the prostate to determine its characteristics, and plan the operation accordingly; introduce the beak of the instrument through the perineal wound into the bladder, turn and hook it over the part of the prostatic obstruction to be attacked; insert the index finger into the rectum and bear down on the beak until the point is felt at the anterior wall of the bowel above the prostate (Fig. 1527); adjust the flow of water for cooling, and note the time for operative purposes; close the electric circuit, allowing five seconds for the knife to heat; slowly withdraw the knife, taking a minute to a minute and a half for the purpose, and a quarter of a minute for its return; remove the instrument from the bladder, flush through the perinæum with sterile cold water the incised tissue and introduce the finger into the

FIG. 1526.—Chetwood's galvano-prostatic incisor.

wound to estimate the effect of the preceding incision and to determine the need for others.

The Precautions.—If obstruction remains after division the floor of the urethra being higher than that of the bladder, enucleation should be practiced through the line of the incision; careful manipulation and thorough cleansing are essential to success.

The Remarks.—A single lobe may be divided through the center, or where it "holds up a bar of membrane." Bilateral obstruction is treated in a similar manner at each side. Before attempting to use the instruments, test them to see if they are in order.

The After-treatment.—Keep the bladder clean by boric-acid injections through a perineal tube kept in place four or five days. Partial or complete urination takes place by the normal channel during the second week. Urethral catheterization, or the passage of a sound during the later stages

Fig. 1527.—Chetwood's perineal galvano-prostatotomy operation.

of treatment, hastens the return of the normal function. The perineal wound will close as a rule in from four to six weeks.

The Results.—Of 52 operations performed on 50 patients, 5 died shortly after, 1 from sepsis due to the operation; 3 from agencies active before operation and unchecked by it; 2 from causes foreign to the operation. The remaining 44 cases are alive to-day, several of them more than three years after the operation. Some cases got immediate relief, others not until the end of six months. Briefly stated the results of operation are: Direct mortality, 2 per cent; died within two months, 10 per cent; unim-

89

proved, 4 per cent; incontinence of urine, 4 per cent; greatly improved, 6 per cent; cured, 74 per cent (E. L. Keyes, Jr.). *Bottini* reports 67 per cent of cures, 15 per cent unimproved, 15.85 per cent no report, and 2.6 died, in a series of 77. Of 1,086 cases operated on by this method, 6.3 per cent died from the operation; 52 per cent of the fatalities were due to sepsis. Of the recoveries, the ultimate outcome in 490 cases was cured in 149 (30.4 per cent) (Watson).

Clark, *Meyer*, *McGowan*, *Guitéras*, and many others have contributed their confidence in the method, as emphasized by their operative efforts.

Fig. 1528.—Curved transverse incision of perinæum for access to prostate, seminal vesicles, etc. Curve should conform to outline of incision in Fig. 1331 in latter instances of access.

However, the element of uncertainty that attends operations conducted in the dark still haunts this procedure.

Prostatic Abscess.—Prostatic abscess is preceded usually by an acute parenchymatous inflammation of the prostate body. The common directions of pointing of the abscess are toward the urethra, rectum, and the

perinæum. Infrequently they point in the inguinal or the obturator region; sometimes in the space of Retzius and the peritoneal cavity. Prostatic abscess should be opened and drained as soon as the diagnosis is made, in order to forestall the escape of the pus into either of the places already indicated.

The Operation (Dittel and Zuckerkandl).—Evacuate and cleanse the rectum; shave and scrub the perinæum; place the patient in the position for
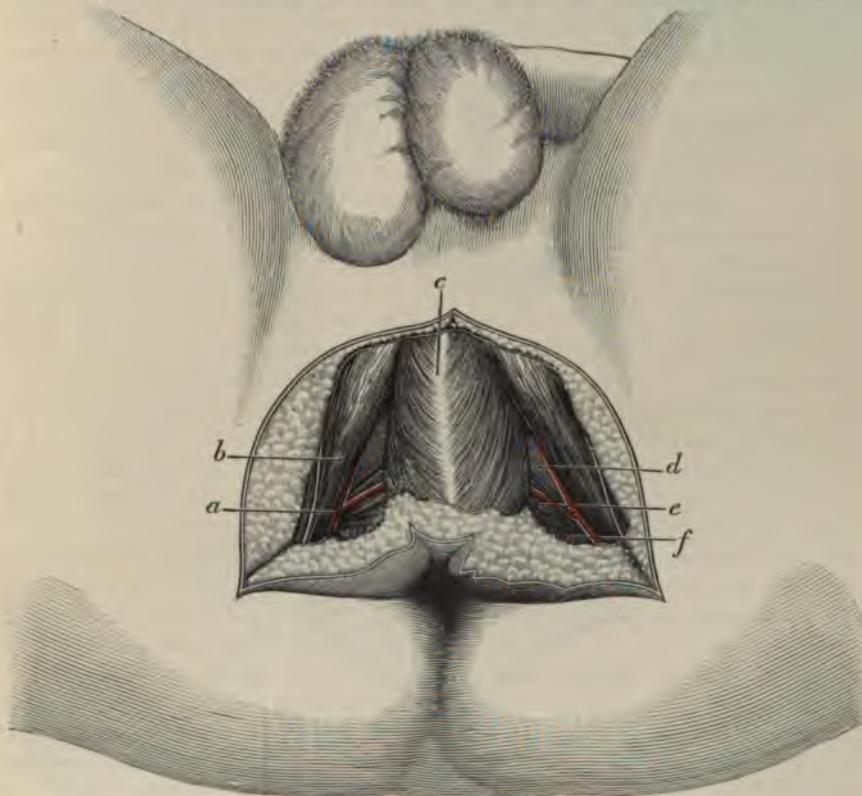
Fig. 1529.—Superficial surgical anatomy of perinæum. *a.* Superficial perineal vessels and nerves. *b.* Erector penis muscle. *c.* Accelerator urinæ muscle. *d.* Triangular ligament. *e.* Transversus perinei muscle. *f.* Levator ani muscle.

perineal lithotomy; introduce a large sound into the bladder and give it in charge of an assistant; pass the left index finger into the rectum; begin a convex incision at the right between the tuber ischii and the rectum, and carry it forward to the posterior limit of the bulbous urethra, thence symmetrically backward to a point at the opposite side corresponding to that of starting (Fig. 1528); divide the superficial fascia of the perinæum along the line of incision and enter the ischio-rectal fossa at either side (Fig. 1529); separate the flap and turn it backward as far as the lower surface of the sphincter ani muscle; push at the same time the hæmorrhoidal vessels and nerves backward and the superficial perineal vessels and nerves an

80*

the bulb forward; divide the connecting fibers between the external sphinc-
ter ani and the accelerator urinæ muscles transversely, and draw the bulb-
ous urethra forward; sever the anterior layer of the deep perineal fascia
from the fascia in front of the levator ani at the bulb (anal fascia), and
draw the muscle, the fascia, and the lower end of the rectum backward, thus
exposing the deep layer of the triangular ligament at that situation, the
compressor urethræ muscle, and Cowper's glands; dissect upward through
the fascia without cutting; sever the transverse muscular fiber layer that
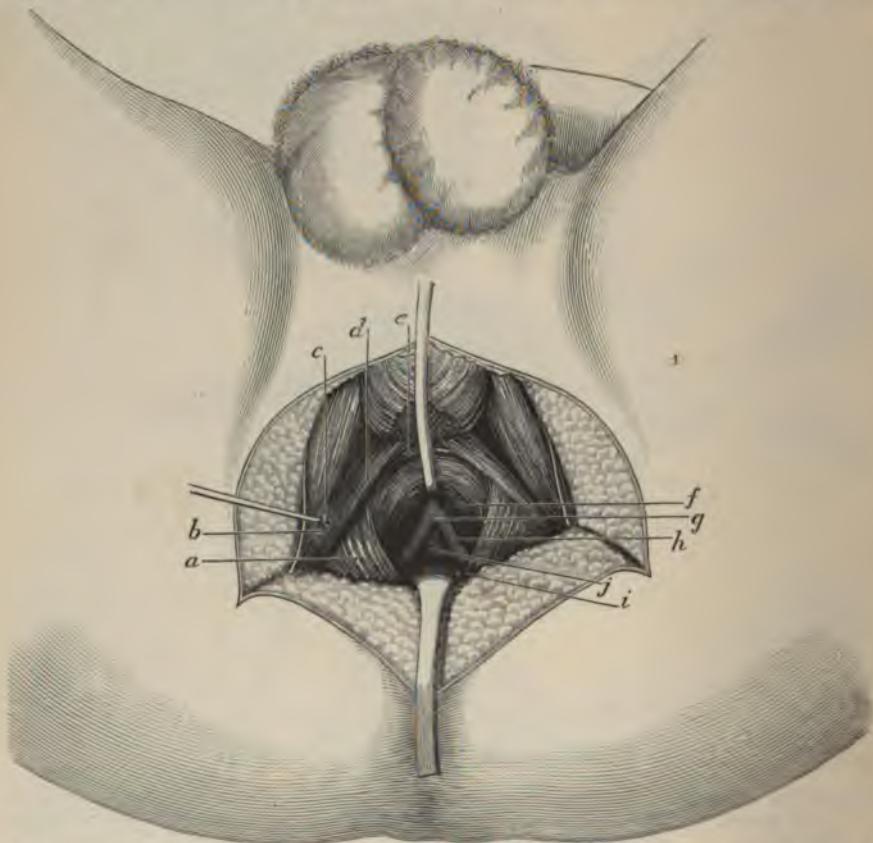
Fig. 1530.—Deep surgical anatomy of perinæum. *a.* Levator ani muscle. *b.* Internal
pudic nerve. *c.* Internal pudic artery. *d.* Transversus perinei muscle. *e.* Fibers
of compressor urethral muscle. *f.* Prostate body. *g.* Vas deferens. *h.* Vesicula
seminalis. *i.* Rectum. *j.* Bladder.

connects the anterior bundles of the levator ani muscle at the anterior sur-
face of the rectum; separate and draw aside the fibers of the levator ani so
as to bring into view the posterior surface of the prostate and the seminal
vesicles higher up (Fig. 1530); open through the sheath of the prostate into
the abscess cavity carefully; evacuate, wash out the abscess, and drain with
a small tube or gauze wick; close the external wound with silkworm gut, ex-
cept at the center of the perinæum, which is left open for drainage purposes.

The abscess can be opened satisfactorily in thin subjects by a median perineal incision made behind the urethra into the sheath of the prostate. After the detection of pus by the needle or by palpation, introduce the left forefinger into the rectum and locate the fluctuating point; failing in this, place the end of the finger at the apex of the prostate. Introduce (without removing the finger) with the cutting edge upward, a long, straight, narrow bistoury at the median line of the perinæum, three quarters of an inch in front of the anus, and thrust it upward to the abscess, guided by the fingers in the rectum; enlarge the incision upward sufficiently, on withdrawal of the knife, to afford free exit for pus; explore the cavity with an aseptic finger, breaking down abscess partitions when found; irrigate the wound with a hot saline solution, and arrest profuse deep hæmorrhage by packing.

In either instance the tube should be removed after a few days and gauze drainage only employed, allowing union by granulation.

The Remarks.—If pus be located with a needle, let it remain as a guide to puncture of the abscess. The depth of the pus from the surface will depend on the amount and extent of the suppuration, and the thickness of the perinæum. A depth of an inch or two at least may be expected. Avoid perforating the rectum or urethra in making the incision. Abscesses ought not to be opened into the rectum unless the mucous membrane only be interposed, then dilatation of the sphincter should follow at once. If the abscess have opened into the urethra, perineal section should be performed, the prostatic urethra dilated, and the bladder drained for ten or twelve days, or until the abscess cavity is healed. The space of Retzius (Fig. 1583) can be drained through the perineal opening with gauze or small rubber tubes. Improperly drained prostatic abscess is complicated not infrequently with fatal phlebitis. Prostatic abscess sometimes opens into the ischio-rectal fossa (Fig. 1407), and is then difficult to heal, because of the numerous sinuses that complicate it.

The Results.—Wide-apart conclusions are reported as to the rate of mortality—from 3 to 30 per cent are given. In our opinion the former estimate is the more correct of the two. About 40 per cent of the deaths are due to prostatic phlebitis—a figure which may be regarded as a low estimate, indeed, for such a disease and its sequels.

The seminal vesicles and vasa deferentia can be reached through the convex incision (Fig. 1529), but with some difficulty because of its depth. *Rydygier's* osteoplastic flap in proctotomy (Fig. 1435) affords easy access and free view on pushing aside the rectum and partially distending the bladder. *Dittel*, after passing a catheter and stuffing the rectum with gauze having a string attachment, placed the patient in the same position as for operation on the prostate, and exposed the seminal vesicles through a like incision (Fig. 1512). *Roux* attained the purpose well through a straight four-inch incision made an inch to the left of the median line of the perinæum.

Extroversion of the Bladder.—In extroversion of the bladder the anterior wall of the bladder and abdominal parietes are absent, while the posterior and inferior portion of the bladder protrudes through the opening in

the abdominal wall on account of the pressure of the viscera behind it. Various measures have been attempted to establish a more feasible channel for the escape of urine, none of which, however, has afforded any practical benefit. *Simon* made an attempt to connect the ureters with the rectum, but with no practical success. *Floyd* and *Johnson* attempted to establish a fistulous communication between the bladder and rectum by means of setons, but the patient died shortly after from peritonitis. *Sonnenburg* extirpated the bladder (page 1370), united the ureters with the dorsal groove of the penis, and closed the abdominal wound with flaps; the outcome was more of a surgical than a practical triumph. The methods of autoplasty are the most rational, and have in many instances afforded substantial relief.

The operative treatment may be begun as early as four years of age, the sooner, within the reasoning limits of the patient, the better, as the time employed in the cure may exceed a year or two. The patient's physical condition should be good, and the parts should not be disturbed by emotional causes. All evidences of local irritation should be subdued and irritating influences removed or ameliorated. The practice of the late Greig Smith bearing on a case of this kind is very important. He kept the
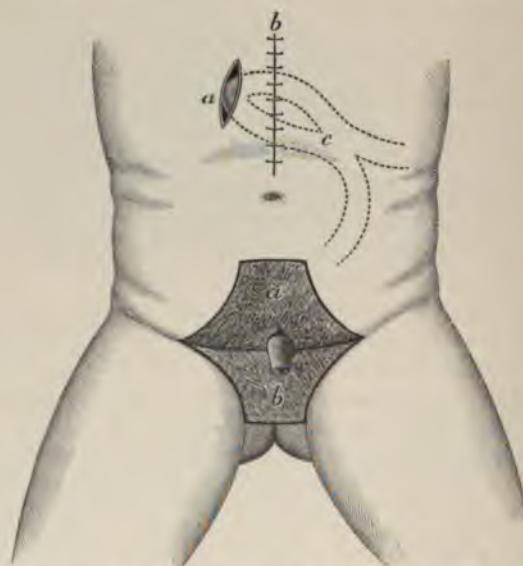
FIG. 1531.—Maury's operation for extroversion of bladder. *a'*. Reflected perineal flap. *b'*. Denuded surface. *a, b, c*. Jejunostomy, Albert's method (page 766).

patient on the back for fourteen days, hoping to diminish the size of the tumor by removal of the weight of abdominal contents. In order to exclude atmospheric or other sources of irritation, and limit the deposition of phosphates by the prevention of evaporation, he covered the mucous membrane of the deformity with oiled silk coated with dextrin and overlapped with a double layer of boric lint. Bland and demulcent drinks were freely given.

He found that " under this treatment the surface of the extroverted mucous membrane soon became less red and angry looking, and latterly, over its upper half, as low down as the orifice of the ureters, it became covered with true epidermis almost as white as that of the surrounding skin. The muco-purulent discharges diminished considerably in amount, and the excavations in the contiguous skin entirely disappeared." The presence of hair on the reversed flaps provokes the deposit of phosphates, especially in the older patients. Therefore, the capillary growth should be destroyed with nitric acid or electricity before the utilization of the surface. However, in very young subjects depilation is not needed, as the perversion of use seems to prevent the capillary growth.

Maury's Method.—Make a curvilinear incision on each side with the convexity upward, extending from the outer third of Poupart's ligament
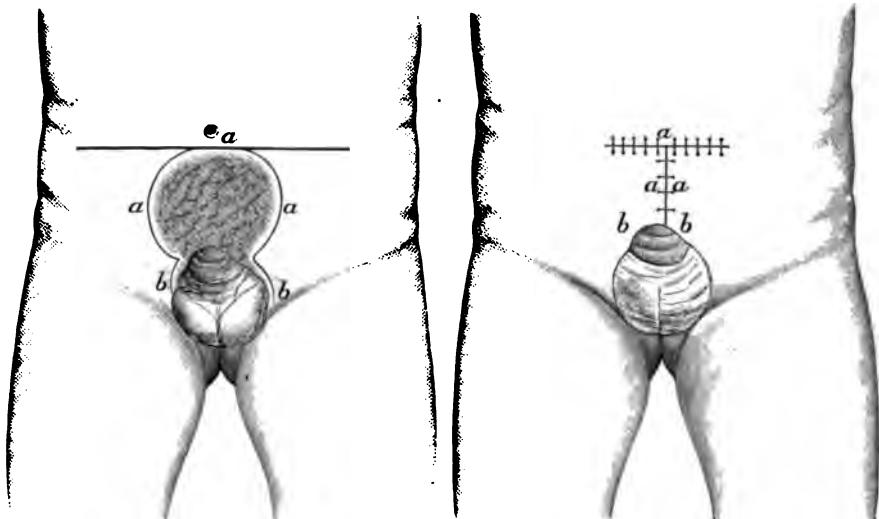
FIG. 1532.—Bigelow s operation for extroversion of bladder.   a, a, a. Flap-dissected borders.   b, b. Flaps from inguinal region.

FIG. 1533.—Bigelow's operation for extroversion of bladder completed.   a, a, a. Borders of incisions united.   b, b. Inguinal flaps in place.

downward and inward below the scrotum to the perinæum, at which point the two incisions become joined by a short transverse incision b (Fig. 1531). This flap is dissected upward over the scrotum to the root of the penis, which is then slipped through a valvelike incision made at the base of the flap, thus permitting the urine to escape without coming in contact with the raw surfaces above. A second or abdominal flap is now formed by carrying a transverse incision across the abdomen below the umbilicus and a curvilinear one around the defect, as in Bigelow's operation (a, a, a, Fig. 1532). A short circular flap is then formed by dissection of the borders of the defect for about an inch. The lower flap (Fig. 1531, a') is then turned upward to bring its cutaneous surface in contact with the mucous surface of the bladder. The cuticle around the borders is removed, so that the borders

can be placed in contact and united with freshened surfaces. The borders of the lower flap are fashioned and beveled so as to slip under the circular flap at the border of the defect, to which it is united by catgut or quilled sutures. This method offers good results in operations upon males. *Bigelow* dissected off the mucous membrane of the exposed bladder down to a line with the ureters (Fig. 1532), constructed lateral flaps from each inguinal region, united them in the median line and above (Fig. 1533), and thereby secured a perfect result. Skin grafting (page 575, vol. i) can be employed in the healing of surfaces denuded for the purposes of repair.

Wood's Method (Fig. 1534).—Wood's method can be employed in both sexes, but is better adapted to the female. It consists in making a central or umbilical flap (*a*), after which a lateral flap is made from each groin
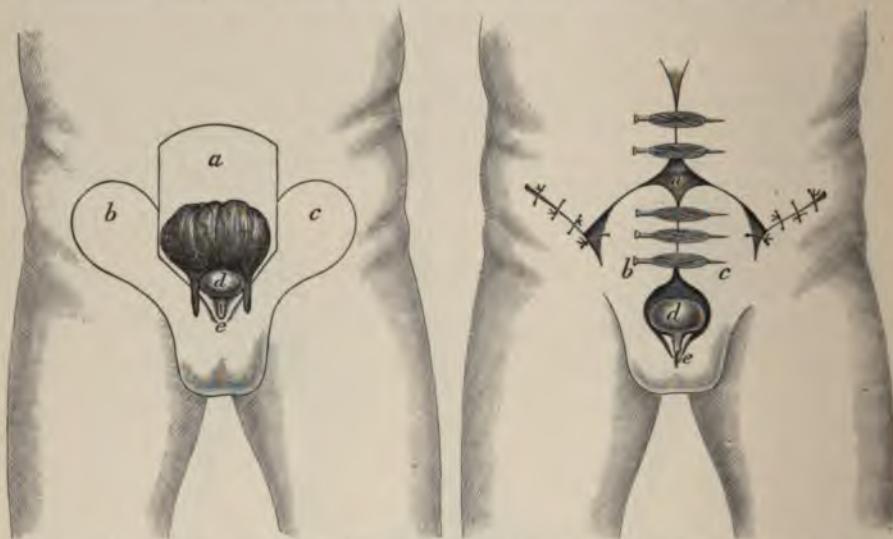
FIG. 1534.—Wood's operation for extroversion of bladder. *a*. Central flap. *b, c*. Lateral flaps.

FIG. 1535.—Wood's operation for extroversion of bladder. *a*. Upper flap, raw surface. *b, c*. Lateral flaps. *d*. Prostate body. *e*. Penis.

(*b, c*), and carried inward over the previously everted central one and united in the median line to each other.

The Operation.—The central flap (*a*) is measured upward by a line extending at either side of the bladder from a point opposite the root of the penis to as far above the bladder as from the root of the penis to the upper margin of the bladder, and joining each other across the median line of the abdomen in a curved manner (Fig. 1534). The two lateral flaps (*b, c*) are made having rounded external borders, with their attachments downward and inward, corresponding to the base of the scrotum and large enough, when properly detached and turned inward, to meet in the median line their entire length. Their upper limits correspond internally to the centers of the vertical incisions. The incision, completing the inner border of each flap, is carried from the lower end of the vertical incision already made

along the side of the urethral groove for half its length. After proper separation of the flaps the central or umbilical flap is turned downward and
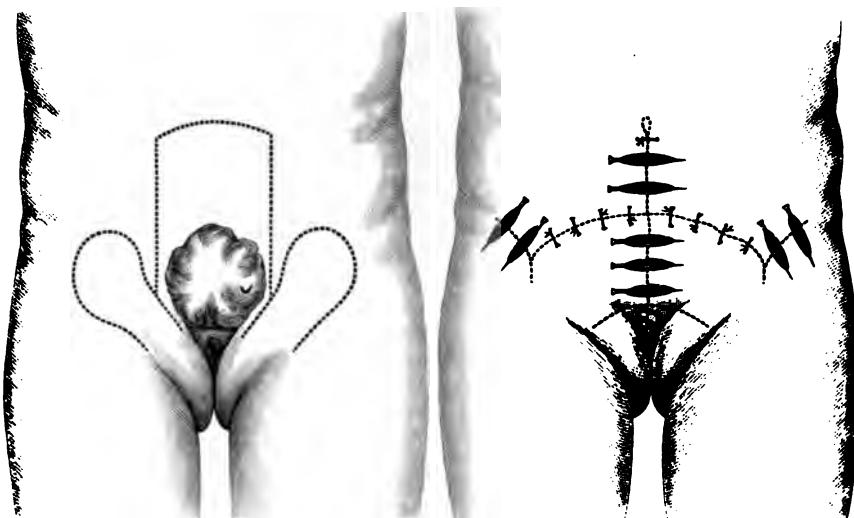
FIG. 1536.—Robson's modification of Wood's operation. Formation of the square and pyriform flaps.

FIG. 1537.—Robson's modification of Wood's operation. Flaps placed in position and borders secured.

stitched at either side to the cut edges of the root of the penis. The lateral flaps are carried inward over the umbilical flap, thus apposing the raw sur-
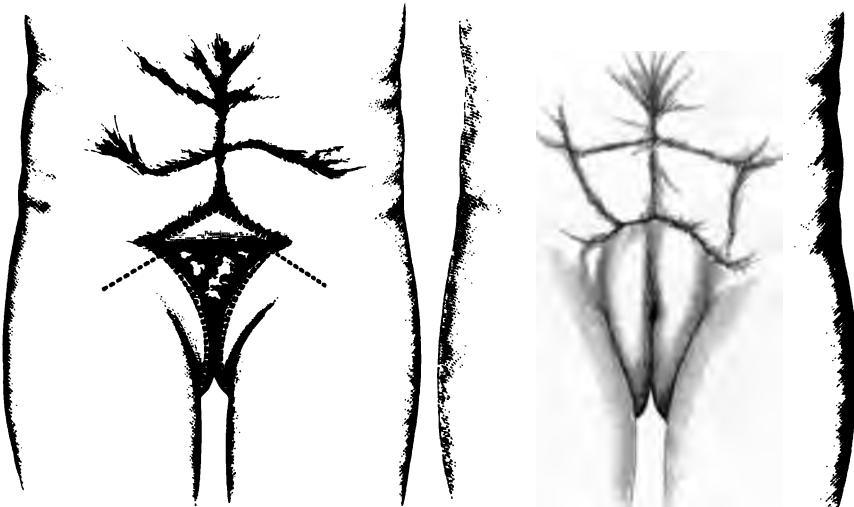
FIG. 1538.—Robson's modification of Wood's operation. Secondary operation to remedy effects of retraction.

FIG. 1539.—Robson's modification of Wood's operation. Results of secondary operation.

faces of the respective flaps to each other. The flaps, and the borders of the gaps resulting from their displacements, are united

tration (Fig. 1535), leaving the unclosed spaces to heal by granulation. The root of the penis should be closely embraced by the lateral flaps to prevent subsequent weakness and protrusion at this point. The integrity of the external pudic vessels will add much to the vitality of the lateral flaps. Aseptic precautions and careful handling of the flaps are important desiderata.

The Comments.—The flaps should be made of as nearly *uniform thickness as possible and not too thin,* as then they will slough. At the upper margin of the bladder the tissues are so thin that the peritonæum may be cut unless care be taken. Harelip sutures need not necessarily be employed.

Modifications of Wood's Operation.—*Robson* modified Wood's operation in a case of his own in the following manner: " A large square flap was taken from the abdominal wall above the umbilicus and turned downward so that the cutaneous surface came in contact with the exposed vesical mucous membrane (Fig. 1536). Pyriform flaps, one on each side, were taken from the lateral aspects of the abdomen and twisted inward on their attachments, so that their raw surfaces came in contact with the raw surface of the first-mentioned square flap. When secured in position the flap entirely covered the vesical surface. The edges of the exposed surfaces on the abdomen were drawn together and secured by harelip pins and sutures " (Fig. 1537). The retraction incident to healing brought into view a part of the lower vesical surface. " To remedy this defect the prominent folds of the integument forming the labia majora were incised for three inches vertically, and from the upper ends of these cuts incisions were carried outward so as to allow two triangular flaps of skin to be carried upward (Fig. 1538). The square flap of skin was loosened at its attachment to the pyriform flaps, and turned downward so that the cutaneous surface again covered the bladder mucous membrane. The newly made groin flaps were approximated toward the middle line covering the raw surface, and secured in apposition for an inch and a half, while the upper margins were sutured to the newly refreshed lower margins of the pyriform flaps of the Wood operation " (Fig. 1539).

Greig Smith formed the flaps a little larger than Wood did, and shaped the umbilical one to conform to the shape of the wooden portion of an ordinary bellows, the handle to which was located above and in the median line, and when turned down and united to tissues raised from the penis and scrotum repaired the defective urethra. Quilled sutures were employed to unite the flaps.

Thiersch's Method.—Form successively two lateral flaps, each large enough at the time of the making to cover the entire defect. Begin the first flap by making an incision from the upper margin of the defect downward along its border to the root of the penis; begin the second incision the width of the defect to the outer side of the commencement of the first, and carry it down parallel with the first to Poupart's ligament; detach the flap between the extremities, leaving the latter undivided; place beneath the flap tin foil for three weeks while awaiting granulation; freshen the margin of the lower portion of the defect, and divide the flap at the upper end; turn the flap downward so as to cover the lower part of the defect and attach it

to the border of the freshened margin, with the cutaneous surface upward; freshen and unite the end of the flap with the contiguous freshened border of the defect after the former is securely fixed in place. After the first flap becomes firmly attached, make the second of the same dimensions as the first and correspondingly located, except that the lower limit should conform to the upper border of the first one. Treat the second in a like manner as the first for a similar time, and then repair the upper part of the defect with the second flap in the same manner as the lower part was repaired by the first. After a secure union of the second flap, unite with each other the contiguous borders of the two, and also the upper border of the second with the freshened upper margin of the deformity. Repair the urethral deformity at a later period.

The Remarks.—By this method a thin, illy-nourished umbilical flap and the dangers attending its construction are avoided, and, instead, flaps with established vitality are employed.

Modifications of Thiersch's Method.—When it is impossible to close entirely the defect by *Thiersch's* method, Segond recommends that a smaller bladder be formed in the following manner: After freshening the borders of the penile furrow, form a new vesical cavity with the material of the old by an extraperitoneal dissection downward of the mucous membrane of the bladder. The mucous flap is turned forward and downward and sutured to the freshened penile furrow. Then make an incision through the prepuce, dissect it up, draw it over the glans penis, and its raw surface, with that of the lateral abdominal flaps, is employed to cover the mucous membrane limiting the newly formed bladder.

The Remarks.—The difficulty of dissecting away the mucous membrane without impairing its integrity, or implicating the peritoneal cavity, is the chief objection to this operation. The base of the mucous flap corresponds to a point just above the attachment of the ureters to the muscular wall of the bladder.

Pousson, with the idea of avoiding the objectionable features just stated, made a flap of the exstrophied bladder by carrying an incision around its border into the peritoneal cavity. This flap is utilized in repair the same as the mucous flap, and the consequent defect in the abdominal wall is directly sutured.

Billroth, in 1881, expressed himself as follows: "At first I used to cover over the extroversion by paring and uniting the abdominal walls after previously detaching the bladder from them. Then for a while I tried making two lateral pedunculated flaps from the abdominal wall. Now I have come to the conclusion that the best method is to dissect up two broad, lateral, doubly pedunculated flaps, whose narrow parts lie above and below. After ten or fourteen days, when the under surface is granulating well, I unite the two in the middle line without cutting through the pedicles. If the flaps be sufficiently broad, there is no need to unite them by their outer edges; these lateral openings close spontaneously in from five to six weeks. The bladder is thus completely covered in, but an opening should be left at the umbilicus through which the urine may escape until the urethra below is completely formed; then the umbilical

opening is closed, and it heals up as the urine escapes below by the newly formed passage.

"The flaps must be made very broad—that is to say, in an adult they should be at least six centimeters broad in the middle and about five at the upper and lower parts; in a child, of course, they should be somewhat, but still not so very much, smaller. The flaps should be so completely detached as to overlap each other for about half their width; a sheet of tin foil is then laid underneath them in their whole length. In a few days they approximate so much that their curved shape becomes straight; later on, notwithstanding a certain amount of rigidity, they will readily unite in the middle line. A broad surface must be made by scraping away the granulations and the superficial developing epidermis from the edges. At first I suspected that this median cicatrix might possibly give way as the bladder was pressed forward, so that a sort of vesical hernia might form, as happens occasionally under similar conditions after laparotomy. I have, however, a case under observation which was cured five years ago, and which satisfactorily proves that such a fear is groundless.

FIG. 1540.—The operation of uretero-trigono-sigmoidostomy. Maydl's method. Peterson's rectangular flap; ureteral openings shown and ureters exposed.

"The wounds of the abdominal wall, after the formation of flaps on both sides, are of rather formidable size. The hæmorrhage can easily be controlled. If the flaps be made too small, a strip of the tissues either about the center or above it is apt to slough. Such an occurrence will seriously depreciate the result. A further disadvantage of making the flaps too small is that lateral openings will be left which are very difficult to close."

The approximation of the innominate bones as an element of cure in this deformity has attracted considerable notice and given rise to many ingenious conceptions of repair. The presence of a gap of two inches or more between the pubic bones in exstrophy of the bladder has long been recognized, and the possibility of closing the gap considered. Trendelenburg regards five years of age as the best period for operation, and practices the following plan of action:

Trendelenburg's Method.—Note the degree of separation of the bones in front, and, under aseptic precautions, expose and divide the posterior sacro-sciatic, interosseous, and superior ligaments of the articulation; freshen and approximate the pubic bones so as to close the gap; close and drain the posterior wound, and apply suitable dressings and a retention

band. The use of transverse traction (Makins), of elastic extension, or an extension by weights applied to each of the crossed ends of a pelvic band, will hold the pubic bones in contact. It is hardly necessary to say that defilement of the point of juncture will delay union, and may develop unfortunate inflammatory complications.

The Remarks.—This operation is better adapted to the male than the female sex, owing to the objectionable narrowing of the pelvis in the latter sex. The anterior iliac spines are the bony points for estimating the degree of approximation, and although easy closure of the vesical defect is gained, an absolute value can not yet be placed on the operation.

König and *Küster* substituted for the sacro-iliac separation osteotomy of the pelvic ring. *Passavant* proposed closure by "brisement forcé" under anæsthesia. Later operators regard with disfavor all of these attempts, because of the primary and secondary dangers attending them, and also the fickleness of the results. The various transplantations of the ureters into the rectum, colon, etc., with the view of relieving the patient of the almost insufferable nuisance of the dribbling urine, are considered under the Surgery of the Ureters (page 1042 *et seq.*). *Harrison* removed one kidney, waited until the remaining kidney had undergone compensative hypertrophy, then transplanted its ureter into the groin and collected the urine with a suitable apparatus. The change of condition brought about by this course of action afforded the patient great relief. Repair of the bladder by transference to the defect of intestine has been practiced.

Fig. 1541.—The operation of uretero-trigono-sigmoidostomy. Maydl's method. Showing incision through serous and muscular coats and Peterson's vesical flap being sewed to bowel with right-angled through-and-through continuous suture.

Uretero-Trigono-Sigmoidostomy (*Maydl's Operation*).—This plan of operation is attended with comparatively remarkable success. The mortality is small, the rectum is tolerant of the presence of urine, the sphinc-

ter ani exercises satisfactory control of the accumulation of urine, and the danger of ascending kidney infection is reduced to a minimum.

The Operation.—Anæsthetize the patient and then thoroughly cleanse the rectum and colon; make a vertical incision about five inches in length in the median line above the symphysis pubis down to the peritonæum; enter the cavity of Retzius and raise the peritonæum from the abdominal wall and from the fundus of the bladder; make a free incision through the fundus of the bladder and inspect its interior; strip the peritonæum from the fundus and posterior surface of the bladder down to the ureters; introduce into each ureter for two or three inches a catheter, thus better locating the ureters and fixing the trigone and removing the urine from the field of operation; cleanse by wiping the mucous membrane of the base of the bladder; cut from the base a rectangular (Peterson) or an elliptical-shaped piece so as to include the orifices of the ureters and a margin of about half an inch (Fig. 1540);

Fig. 1542.—The operation of uretero-trigono-sigmoidostomy. Maydl's method. Showing the method of turning angle ("single stitch"). The inversion of the Peterson flap.

extirpate the bladder with care, leaving the prostate and the ureteral flap undisturbed; open the peritonæum by a vertical incision of sufficient size to permit of the sigmoid being drawn through the opening and constricted above and below the point for implantation; incise the sigmoid along the fibrous band, at a convenient point for implantation, down to the mucous membrane, for a little less distance than the length of the vesical flap; raise cautiously the bladder flap, avoiding injury to its vascular supply and that of the ureters, and unite it by right-angled stitching (serosa to serosa when possible) with one side of the intestinal incision (Fig. 1541); make a single stitch only when the lower end of the wound is reached (Fig. 1542), thus saving time; push the mucosa of the flap toward its center and begin sewing the opposite border in place

(Fig. 1543); remove sufficient of the bowel mucosa with scissors to permit the ureteral orifices to correspond with the opening, when one third of the remaining side is sutured; complete the sewing and fortify the line of union by continuous or independent Lembert sutures.

The Precautions.—Great care should be taken not to impair the circulation of the flap and of the ureters, since that of the latter contributes to the former. The peritonæum associated with the ureters should be separated gently. The lines of suturing of the flap with the bowel should not be made needlessly tight nor numerous, for fear of impairing the nutrition. The flap should be kept warm during transference and suturing, and be gently treated in all other respects. The bowel should be kept as quiet as practicable during the first week, and distention controlled by a rectal tube. Thorough cleansing of the bowels and use of sterilized food for a time before and following operation will not be amiss.

The Results.—*Lewis* reports seventeen cases, with two deaths, one from shock, the other from infection. One case died after four months from pyonephrosis. " Urinary continence was perfect in all of the cases excepting two." The urine could be held from three to seven hours, and in one instance the entire night. The tolerance of the rectum permitted the urine to appear with or without fæcal matter, as the condition demanded.

Peters has practiced extraperitoneal transplantation of the ureters into the rectum

Fig. 1543.—The operation of uretero-trigono-sigmoidostomy. Maydl's method. Showing the opening of the bowel by removing the mucous membrane with scissors. The Peterson flap.

for relief of exstrophy of the bladder several times in the following manner: Unload the bowels by catharsis and cleanse the rectum thoroughly with aseptic solutions and distend the sphincter; introduce a soft rubber catheter (No. 5 to 7 English) into each ureter a distance of two or three inches after cutting off the part containing the eye (Fig. 1545), fasten the catheter in place by means of a fine silk suture passed through

the end of the papilla of the ureter and the side of the catheter, dissect free the distal end of the catheter with a goodly rosette-shaped piece of the bladder wall (Fig. 1545) with scissors or scalpel; free by blunt dissection the rosette-shaped flap, and the ureter along the wall of the pelvis without injuring the peritonæum; ablate the bladder, leaving the prostate and seminal vesicles uninjured, carefully avoiding the peritonæum, aided by the finger of an assistant in the rectum; introduce the finger into the rectum and determine the exact points at the *lateral* aspects of the bowel at which the ends of the ureters are to be brought through into the lumen; pass a slender forceps through the anus along the finger to the point in question, lifting it into view through the anterior wound; incise the projecting part of the wall of the rectum upon the point of the forceps, allowing the latter to pass through the wound; enlarge the wound by stretching and cutting, so that the rosette end of the ureter will fit it accurately without undue pressure; open the forceps, grasp the distal end of the catheter (Fig. 1545), draw it into the bowel and out the anus (guarded by the finger), bringing the end of the ureter through the slit at least a fourth of an inch within the mucous membrane of the rectum; omit stitching
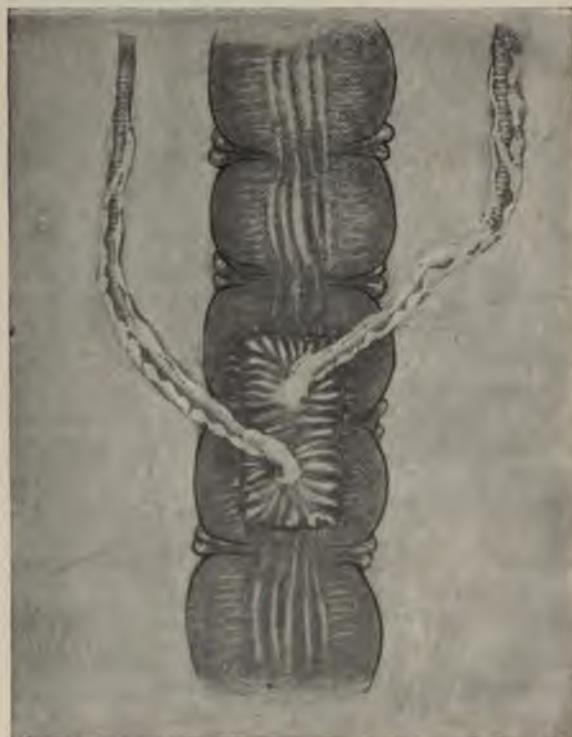
Fig. 1544.—The operation of uretero-trigono-sigmoidostomy. Maydl's method. The Peterson flap united. Peritoneal edges re-enforced by Lembert sutures.

the end of the ureter in place, as the natural relations should hold it suitably; leave the catheters in position for two or three days, if they do not come away before.

The Remarks.—Do not obstruct the lumen of the catheter in passing the stitch through the side. In ablation of the bladder leave muscle attached to peritonæum rather than invade the latter; remove all of the mucous membrane. Avoid stretching of the ureter when placing the rosette end through the wall of the bowel the quarter or half an inch required. If the end of the catheter and the rosette be grasped conjointly the intro-

duction into the bowel is facilitated. Care should be taken to transplant the ends into the *lateral* walls of the rectum, as kinking will happen when introduced at the anterior or posterior aspects of the gut. The abdominal wound is packed with gauze at first and later treated by plastic measures.

The after-treatment in abdominal wall repair is somewhat perplexing, because of the necessity to place the patient and protect the bed so as to prevent objectionable contamination of either with urinary discharges. *Parker* placed his patients in a warm hip bath of a boric-acid solution for
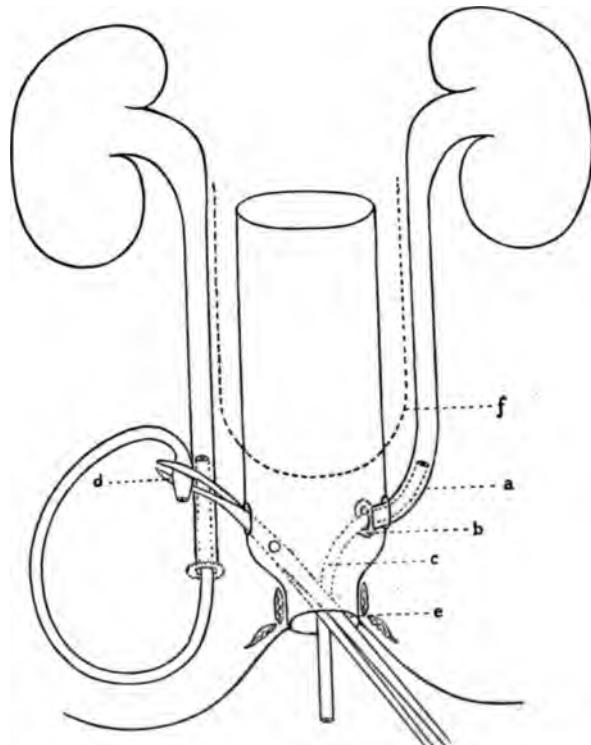
FIG. 1545.—Peters's method. Extraperitoneal transplantation of ureters into rectum. *a.* Ureter with rosette arrangement introduced into rectum. *b.* Junction of ureter and catheter. *c.* Catheter entering ureter united to it with stitch. *d.* Forceps passed up anus into rectum through opening and grasping catheter. *e.* The anus. *f.* Reflection of peritonæum.

days after the operation, with comfort and reparative advantage to the part. Of course, the bath should be maintained at a comfortable temperature, and frequently changed to preserve the requisite degree of cleanliness. Various other measures directed to a like purpose are carried into effect.

The Results in Abdominal Repair.—Control of the bladder while in an erect position is rarely secured by operation; this need is ameliorated by the use of the rubber urinal. However, the urine is often under quite good control in the recumbent posture. The death rate is from 20 to 30 per cent, depending upon the character of the efforts employed.

Pousson reports 52 cases, of which 4 died from the operation; in each of these Trendelenburg's method had been practiced.

Borelius * regards Maydl's plan as being the best of all for relief of congenital ectropia of the bladder. However, since a certain number succumb to ascending infection, with the view of lessening this danger, he suggests that entero-anastomosis be practiced at the root of the flexure with the view of diverting the fæcal flow away from the site of implantation. He aims to attain the entire purposes through five stages, viz.: 1. Dissection
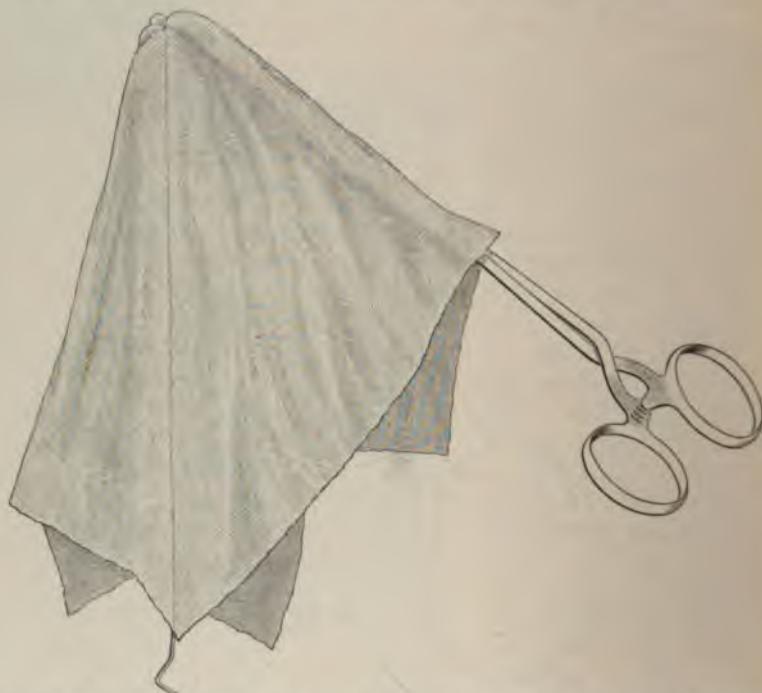
Fig. 1546.—Mikulicz's tampon for arrest of severe oozing in deep cavities. Forceps grasping apex of tampon at the top of investing fabric. String employed in removal tied to apex.

of the bladder from its surroundings; formation of an elliptical piece, including the ureters. 2. Opening the abdominal cavity sufficiently to permit access to the sigmoid flexure. 3. Lateral anastomosis of the limb of the sigmoid at the base. 4. Longitudinal incision of the flexure and implantation of flaps. 5. Attention to bladder and closure of abdominal walls.

Extirpation of the Bladder.—*Partial* and *complete extirpation* of the bladder are practiced; the former (page 1317) for removal of limited cancerous and tuberculous growths, and the latter for extensive ones and for congenital defects.

Küster practiced complete removal of the bladder as follows: After thoroughly shaving and cleansing the parts the patient was placed in the

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* Centralbl. f. Chir., July 18, 1903.

Trendelenburg posture, the bladder exposed above the brim of the symphysis pubis, the brim of the pubis chiseled away, the fragments remaining attached to the muscular insertions above, and the bladder opened for the purposes of inspection. After thorough observation of the interior the opening in the organ was sewed tight and the viscus itself freed by blunt dissection from its surroundings. An incision was made in the median line of the perinæum, the urethra divided transversely, the prostate body grasped with the fingers and liberated by blunt dissection with scissors and fingers. The incision into the bladder was reopened to permit of the localization and exposure of the ureters, which were then tied with silk and severed obliquely from in front backward and upward. The remaining connections of the bladder were severed with scissors, the organ was removed, and the ureters were implanted into the rectum. After thorough cleansing the wound was closed by restoring and wiring in place the fragments of bone and uniting the soft parts in the usual manner.

Hartley * makes a vertical incision in the median line from the pubis upward for four inches down to the peritonæum; enters the prevesical space and raises the peritonæum from the abdominal wall and from the
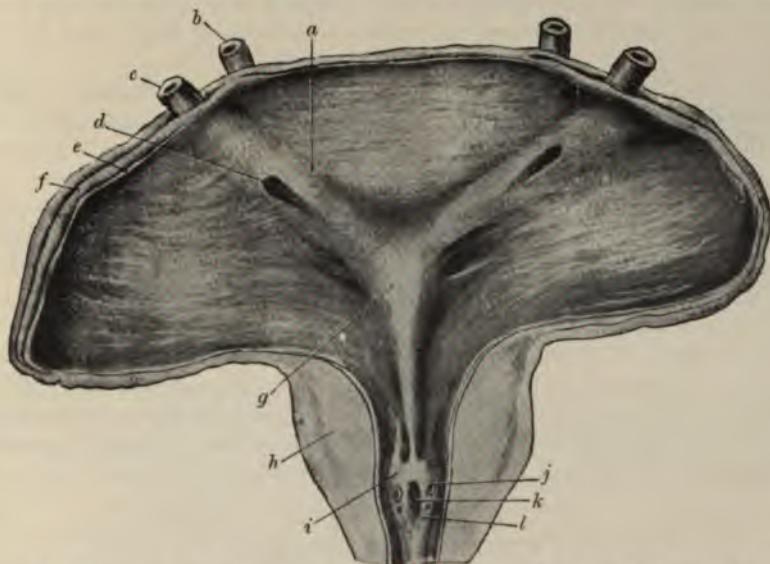
FIG. 1547.—Lower part of the male bladder, with the beginning of the urethra. Exposed by incising the anterior wall and laying it open. *a.* The interureteric fold. *b.* The vas deferens. *c.* The ureter. *d.* The opening of ureter. *e, f.* Coats of bladder. *g.* The center of trigone. *h.* The incised prostate. *i.* The colliculus seminalis. *j.* Orifice of an ejaculatory duct. *k.* The opening of utricle. *l.* Openings of prostatic ducts. (Henle.)

fundus of the bladder; makes a liberal incision through the fundus of the bladder and inspects the interior of the organ; strips carefully the peritonæum from the fundus and posterior surface of the bladder, exposing the ureters at the base of the organ (Fig. 1547); makes the ureters freely

* Medical News, August ?

movable by careful dissection with as little harm as possible to their nutrition (page 1364); removes now the bladder with scissors, leaving undisturbed a suitable bladder flap of the base, including the ureters (page 1364), if transplantation of it to the sigmoid is contemplated; closes the peritoneal incisions at the side and wherever else they may be found, also closes the abdominal wound, draining the prevesical space with gauze.

The Remarks.—If the Maydl plan be not feasible, perhaps then Peters's (Fig. 1545) may be employed. Otherwise the entire bladder can be extruded, and the severed ureters implanted in the bowel by the plan best suited for the purpose. *Frank's* plan of retrovesical anastomosis has been employed satisfactorily in some instances instead of extirpation.

Openings made into the peritoneal cavity during the operation should be at once closed. The hæmorrhage should be thoroughly arrested before the wound is finally closed, even if the use of a tampon (Fig. 1546) be required, as may happen if extensive malignant involvement be unexpectedly found. Thorough drainage should be secured. If the ureters be implanted in the bowel and the bladder left *in situ*, the organ may rapidly shrink and become a round, hard, and indifferent body. The substitution in any manner for the bladder of an intestinal loop does not afford the outlook that has characterized the successful efforts of Maydl and his followers.

The Results.—Complete removal of the bladder for malignant growths has been done 23 times, in 11 of which Maydl's method was practiced, with 6 deaths. Of the remaining 12, 7 were vaginal implantations, 2 urethral, 2 skin, and 1 intestinal and skin, 2, 2, 1, and no deaths, respectively.

Total extirpation of the organ with urethral implantation elsewhere than in the vagina, gives 43.75 per cent recoveries. Partial extirpation with implantation in the reconstructed bladder gives 41.67 per cent recoveries (Hartley). If the vaginal implantations be included, the rate of recovery is increased.

Of 35 cases, 10 survived three years or more. Of 18 cases of epithelioma, only 1 survived at the end of three years. Nine papillomata give 4 relapses and 2 operative deaths. Albarran reports 36 cures in 48 operations for benign and 23 cures in 97 operations for malignant growths. Clado reports 28 cures in 111 operations for malignant disease.

STONE IN THE BLADDER.

Stone in the bladder is quite common, and usually is accompanied by well-marked and characteristic symptoms. Sometimes, however, calculi of inordinate size and with unusual asperities are attended by only trifling manifestations.

The Detection of Stone in the Bladder.—When it is suspected that a stone may be in the bladder the proof of its presence is sought by a searcher, by bimanual palpation, and the use of a cystoscope. The lithotrite, the evacuator, and the ordinary sound can be used for the purpose, but not with the technical skill and surgical justification that belong to the use of the first three means of exploration. There are various patterns of searchers

(Figs. 1548, 1549, and 1550). The one devised by Thompson is most commonly employed. It can be used for the double purpose of regulating the amount of water in the bladder by injection or by outflow, thereby better accommodating the bladder walls to the main object of the use of the instrument—sounding for stone.

The time of sounding for stone should be when the patient is suffering the least from the bladder difficulty. If the patient be a child an anæsthetic should be given, if an adult only when he is extremely restless from the pain. Two or three ounces of a two-per-cent solution of cocain have been employed successfully in the bladder to relieve the pain and irritation of sounding. The urine of one or two hours' secretion should be allowed to collect in the bladder, or its equivalent, four or five ounces of warm sterilized water, should be injected before attempting the act. Not infrequently it is wise to distend the bladder with aseptic fluid before sounding, so that

FIG. 1548.—Thompson's searcher.

FIG. 1549.—Little's searcher.

FIG. 1550.—Gouley's searcher.

the characteristics of the stone and the bladder can be the better estimated by allowing the fluid to slowly escape during the explorative manipulations.

The Operation of Sounding.—Place the patient on the back with the hips raised, the operator standing upon the right side. Introduce the searcher in substantially the same manner as employed in the introduction of a catheter or sound (page 1303); push the instrument carefully to the posterior wall of the bladder, with the beak upward; withdraw it slightly to give easy play to the vesical end, and then carefully turn the beak from side to side until the lateral walls of the bladder are touched by it. This is done by rotating the instrument on its long axis between the thumb and finger. Turn the beak downward and examine the base of the bladder. In this manner the whole inner surface of the bladder is examined, the instrument being withdrawn each time a sufficient distance to accomplish the object thoroughly. As soon as the beak comes in contact with the neck of the bladder the instrument may be withdrawn. If the prostate be enlarged, the handle should be depressed and the beak turned toward the floor of the bladder and rotated from side to side while being gradually with-

drawn. This manœuvre will be quite sure to detect a stone if it be lodged behind the prostate.

If a stone be not detected, it is better to make a second and even a third examination before positively asserting that none is present. Five or ten minutes is quite sufficient time to employ at a sitting. If the presence of stone be detected, the number, size, and the probable consistence should be determined. The presence of two and even three calculi can be reasonably estimated by careful manipulation with the searcher. However, this knowledge is best gained by the use of the lithotrite. If a stone be grasped by this instrument the presence also of one at either side of the beak can be

Fig. 1551.—Andrews's searcher, with a tube to convey the sound to the ear.

determined with reasonable certainty by the alternating "clicks" attending the turning of the beak from side to side. The size of the stone can be estimated approximately with a searcher by noting the extent of the area of friction and distance of the exposure of the shaft of the instrument at the meatus when the beak is applied alternately to the anterior and posterior surfaces of the calculus. The dimensions of the object grasped by a litho-
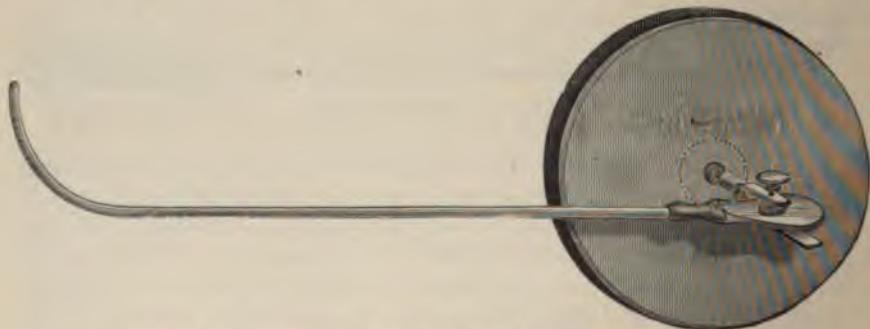
Fig. 1552.—Billroth's sounding-board attached to searcher.

trite can be accurately determined. The distinctness of the click will indicate the hardness of the stone as a rule. A pasty stone will give a soft, low-pitched sound; the reverse will follow contact with a hard one. A hard stone surrounded with organic matter may be mistaken for a soft one. After the searching is completed apply warmth to the hypogastrium, give an anodyne and possibly ten grains of quinine, and keep the patient quiet.

The Comments.—The ability to detect the "click" of small stones and fragments by aid of the searcher is greatly enhanced by the attachment of the so-called "lithophone." This attachment can be extemporized by tak-

ing a piece of rubber tubing, twenty-five or thirty inches in length with an eighth of an inch caliber; double one end upon itself and place it against the handle of the searcher, allowing also the tubing continuous with it to lie along the handle, or push it into the open end of the handle of the searcher. The other extremity is then placed in the ear directly, or connected to it by the medium of an otoscope (Fig. 1551). The ability to detect fragments of an almost infinitesimal size is said to be thus attained (Fig. 1552). The washing process of litholapaxy will also cause the "click," when other measures have failed.

The Fallacies.—The fallacies of sounding are quite numerous, as a stone may be obscured more or less by mucous membrane, inspissated mucus, or blood, and when pocketed in an adventitious place. Calcareous incrustations connected with the wall of the bladder, or with a morbid growth, are sometimes mistaken for calculi. Finally, the instrument may not enter the bladder at all, and thus completely deceive the examiner.

Bimanual Palpation.—Bimanual palpation can be practiced in either sex with satisfactory results if the patient is not of an unusual muscular or adipose development. In the male the patient is placed usually on the back, with the thighs flexed and the shoulders raised so as to relax the abdominal wall. The examiner introduces the index finger of the right hand into the rectum of the patient, and presses the tips of the fingers of the left behind the pubes and the bladder. Between the apposing finger tips an empty
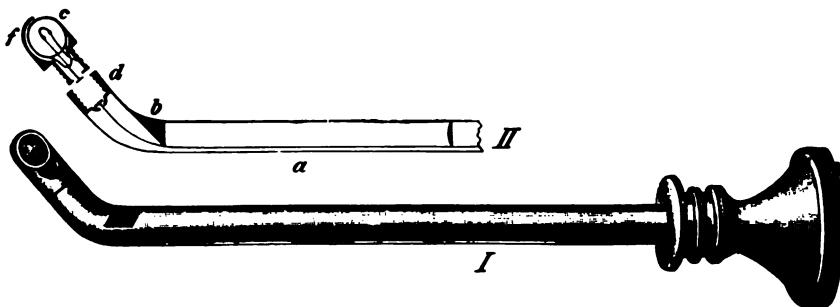
FIG 1553.—*I.* Nitze's cystoscope. *II.* Longitudinal section of *I.* *a.* Shaft. *b.* Prism. *c.* Incandescent light, which is fastened into the small compartment *f.*

bladder can be thoroughly examined to detect in it the presence of a calculus of small size. Any undue pain or mental trepidation incident to the act can be relieved by general or local anæsthesia if the importance of the condition justifies the use. In the female the manipulation is easier and even more conclusive, on account of the absence of the prostate and the intimate relations of the base of the bladder and vagina. In either sex the rectum should be thoroughly evacuated before the examination is begun.

The Cystoscope.—The use of the cystoscope is often advantageous in the determination of morbid conditions of the kidney or the cavity of the bladder, and the interpretation of the functional phenomena of these organs (Figs. 1553 and 1554). *F. Tilden Brown* [*] has perfected " a com-

* Annals of Surgery, vol. xxx, page (~age 642.

posite ureter cystoscope " with which one ureter, or synchronously both ure-
ters of either sex can be readily catheterized (page 1377), the instruments
removed and the catheters left in place when desired. Also this instrument
is an admirable one for other purposes relating to cystoscopy in connection
with and without catheterization of the ureters (Fig. 1555).

Brown advises the following assemblage of accessories to ureteral cath-
eterism: (*a*) Transparent boric-acid or sterile salt solution. (*b*) Anæs-
thetizing, adrenalin and phloridzin solutions. (*c*) Sterile ureteral cathe-

Fig. 1554.
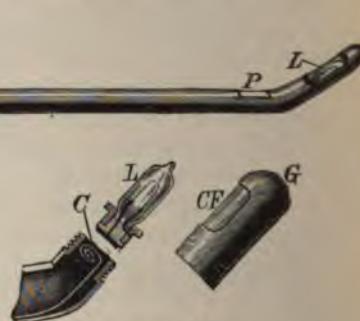
Fig. 1554*a*.

FIG. 1554.—Fenwick-Leiter cystoscope. *Le.* Electrical connections. *Tf.* Telescope.
P. Prism. *L.* Lamp.

FIG. 1554*a*.—Detail of beak. *L.* Lamp. *C.* Connecting wire. *G.* Metal hood. *CF.*
Window.

ters and substances of rubber and metal (prepared by formaldehyde gas
sterilization). (*d*) Laparotomy stockings. (*e*) Tested electric controller
or storage battery. (*f*) Sterile graduated siphonage bottle with stopcock
irrigating tube. (*g*) A nest of sterile glass beakers. (*h*) Sterile glass
syringes with rubber tips of size to fit over or into the free ends of differ-
ent ureter catheters. (*i*) Small sterile bottles for the reception of the
separate urines. (*j*) Tubes of culture media. (*k*) Paper labels (*l*)
Hypodermic syringe. (*m*) Sterile lubricant. "The cystoscope on en-
trance of the bladder is taken in control by the left hand, while the right
removes the obturator, inserts the catheter telescope (already threaded
with its two ureter catheters) and turns on the electric-lamp switch. A
critical inspection of the bladder floor is first made for abnormalities or
lesions, particularly in the region about the ureter mouths. The location of
the latter is gauged by slowly withdrawing the cystoscope until the curved
posterior margin of the interureteric bar or trigone fills the lower half or
more of the cystoscopic field. Sweeping the ocular toward the patient's
right thigh now brings the intravesical lens toward the left ureter mouth,
and *vice versa*.

" In beginning catheterism the left ureter is ordinarily first approached;
this calls for the observer's left eye at the ocular, and left hand con-
trolling the cystoscope, while it leaves the right thumb and forefinger to
advance the left catheter the moment the ureter slit or papilla comes
into view; such an advance after engaging the catheter is continued

carefully for two and a half inches. At this juncture the right hand and the right eye take the places on the cystoscope just occupied by the left. Carefully maintaining the instrument at the same depth and at exactly the same inclination to the horizontal plane of the body it is swept through an arc of about fifteen degrees in the opposite latero-vertical direction to find the right ureter. The curved posterior margin of the trigone is again the guide to keep in view during this transit, in the meantime the thumb and finger of the left hand are on the right-ureter catheter ready to engage its tip in the ureteric aperture the moment this comes into view. Since in action the ureteral meatus in some cases is prone to change its relative level (during emission it is lifted and open, in the interval retracted and closed), consequently if caught in action one should be ready to seize advantage of this favorable opportunity to enter the osculum.

" A short, flexible catheter (fourteen inches long) having been inserted about two inches in each ureter (that in the first one catheterized is car-
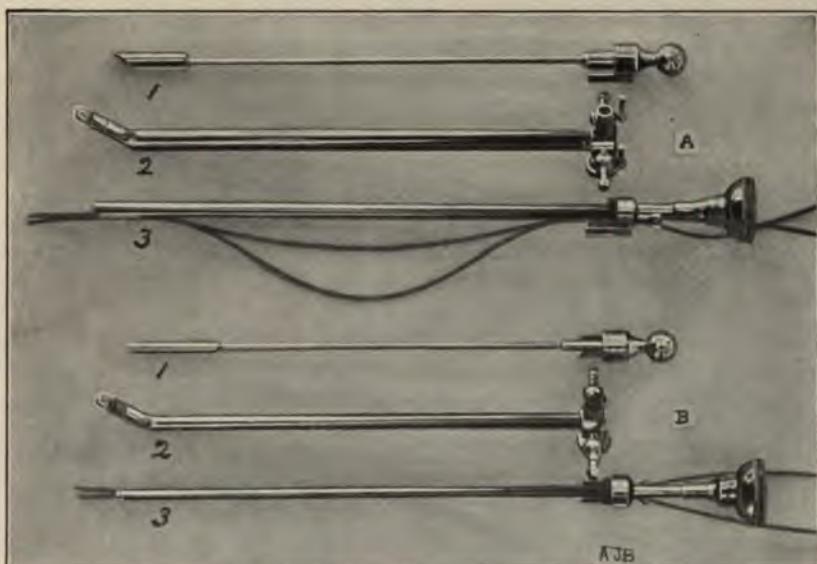
Fig. 1555.—The F. Tilden Brown irrigating cystoscope for synchronous bilateral ureter catheterization.

A. French size (24) for adults of both sexes. *1.* Obturator for the open sheath (2) to facilitate introduction. *2.* Oval sheath bearing exposed cold lamp and irrigating stopcocks. *3.* Direct telescope supporting the catheters, which is passed as a whole into the sheath (2) after this has reached the bladder and on removal of this obturator. *1.* The catheters are drawn down in the center to show fenestration. B. French size (20) of the same oval instrument for use in children and in cases of strictured adult urethra. Nearly vertical view of all parts.

ried a little deeper than in the second to make allowance for the greater withdrawal of the first catheter incidental to transit of the intravesical part of the cystoscope from one ureter to the other, a distance of about one inch), the cystoscope is then brought into midbody alignment and held

there during urine collection, so as to guard against a tendency of the instrument to sink somewhat deeper into the bladder, and thus flex the catheters unduly or effect lateral pressure on the ureter mouths.

"Rubber caps, which up to this moment have closed the free ends of the catheters, are now removed, and the separate urines collected in small sterile bottles which are attached to a spring yolk on the cystoscope. This is a favorable time to inoculate several culture tubes with a few drops from each catheter.

"If the bladder is made uncomfortable by its three or four ounces of distending fluid, this can now be permitted to escape by opening one of the irrigating stopcocks on the cystoscope, and then, if noteworthy discomfort continues, half an ounce of weak eucain or cocain solution can be injected through one of the same channels into the bladder."

If, in exceptional cases of ureter catheterization, one wishes to remove the cystoscope and leave the catheters *in situ*, this is readily done by a slight withdrawal of the telescope to permit grasping the catheters in the open section of their canals, where they are held while the telescope is completely withdrawn and after it the open sheath.

Under these circumstances, or whenever the whole course of the ureters and pelvis of the kidneys are to be explored or treated, full-length catheters are employed. Again, where it is wished to gain fuller information regarding the nature, or relative position of some questionable X-ray shadow showing anywhere in the region of a ureter, the but recently made very flexible long spiral steel catheters are easier to manage and cast a bigger shadow than could be effected in the former method by a fine metal stylet passed into an already introduced silk catheter.

Occasionally a ureter mouth and much of its canal is so patulous as not to be drainable by an ordinary catheter; to meet such cases a telescope having but a single catheter canal of very large size is made to accompany the instrument. This same telescopic tube is equipped to meet other purposes, such as a slightly flexible alligator-jawed forceps for catching foreign bodies or particles of new growth. The eye shield is removable to admit almost rigid instruments to traverse nearly parallel to the telescope.

The Remarks.—Synchronous catheterism of the ureters affords a surer estimation of the relative conditions of the kidneys than separate catheterism, and is also less fatiguing for all concerned.

A detailed description will not be given of the various cystoscopes, as the continual improvements and the extending scope of the usefulness of the instruments forbid a commendation that may soon be of less comparative worth than that which the occasion affords. However, certain established facts regarding the use will not be amiss at this time. 1. The employment of the instrument should be conducted with a strict antiseptic regard in all respects, the same as in other operative procedures on the urethra and bladder. 2. A sufficiently capacious urethra and the presence in the bladder of not less than five or six ounces of clear fluid are always needed. If the urethra be too small it should be dilated gradually and continuously with bougies until sufficient caliber is secured. If the urine be clear the substitution of another fluid is not indicated. If it be cloudy the cavity

of the bladder should be washed out with a boric-acid solution (three per cent), or solution of acetate of lead (one grain to the ounce), or with sterilized water, until the outflow is clear. The presence of blood, pus, or mucus interferes with a cystoscopic examination. The lithotomy position of the patient, with the examiner sitting or standing between the limbs, affords the best opportunity for examination. Either cocain anæsthesia of the urethra and bladder or general anæsthesia can be employed, as circumstances require and the patient's condition will permit. The light should not be turned on until the instrument is introduced into the bladder and the end immersed in the fluid to prevent burning the tissue, and for the same reason the end of the instrument should not be brought in contact with the wall of the bladder during operation. Extended experience is required to properly interpret the appearances and employ the instrument with facility.

Lithotrity, litholapaxy, and lithotomy are the practical methods of relief from stone in the male.

Lithotrity is the reduction of stone to fragments so small as to allow of their easy escape through the urethra with the urine.

The Contra-indications.—The contra-indications to lithotrity and litholapaxy are essentially similar. These operations are not admissible if the bladder be sacculated and affected with extensive cystitis, or if it be ulcerated or intolerant of the presence of instruments. Repeated and severe chills following the introduction of instruments into the urethra or bladder contra-indicate the operation. If the organ contain morbid growths, or if the patient be feeble, especially if the stone be large and hard and complicated with severe cystitis, crushing should not be attempted. In the instance of an enlarged prostate, lithotrity seldom affords prompt or even final relief, and the enlargement may be so great as to prevent proper litholapaxy.

The Preparation of the Patient.—It is wise in all cases, although not necessary in many, that the patient rest in bed for two or three days, and that the bladder be washed out with an antiseptic solution during the time before operation. In cases complicated with cystitis, with or without more extended disease, this course of action is essential. Bland food and diluents are always in order and should be supplemented with iron, strychnin, etc., when the vital forces are depressed. The bowels should be evacuated thoroughly, and the urethra dilated to the proper capacity for safe instrumentation by sounds. The patient is required to hold the urine for an hour or two, and is then placed upon the back with the pelvis elevated; the older the patient the greater the elevation should be. An anæsthetic may be given and should be administered if it be the intention to triturate the entire mass at one sitting, or if the patient be irritable, or the bladder oversensitive.

The Introduction of the Lithotrite.—The operator, having chosen and well oiled a suitable instrument, stands upon the right side of the patient, taking the penis in the left hand, inserts the beak, and draws the member upward upon the instrument, wh   ˙ ˙˙ ˙tly grasped by the right hand. The handle is then slowly r   es vertical, when it is

transferred to the left hand, and the fingers of the right are placed on the perinæum to follow the angle of the beak as it advances (Fig. 1556). The weight of the instrument will cause it to sink low enough to permit the beak to engage the opening of the triangular ligament, through which the urethra passes. A little careful manipulation, aided by the right hand on the perinæum, will cause it to enter this portion of the canal, when the handle of the instrument should be taken by the right hand and allowed to fall slowly of its own weight between the thighs. If the instrument be now slightly pressed upward, its upper extremity will be found to be disengaged and can be easily rotated upon its long axis.

The Comments.—If the prostate be enlarged, the length of the deepest portion of the urethra is increased, and the enlargement interposes an obsta-

FIG. 1556.—Diagram of urethra with blade of lithotrite within it.

cle to the progress of the instrument. The handle should not, therefore, be depressed so rapidly during the latter stage, and the instrument should be pushed farther upward. Under no consideration should any undue force be used. The weight of the handle is of itself sufficient, unless under proper control, to cause laceration of the soft urethral tissues by the advancing end of the instrument. In the healthy bladder the instrument slides easily along the floor to the posterior aspect, often hitting the stone in the passage. In the instance of an enlarged prostate the entry is not so easy, and the stone is often hidden behind it.

The Finding and Seizing of the Stone.—The instrument is pressed upward in the line of its entrance until it reaches the posterior wall of the bladder, unless its course be sooner interrupted by the stone, when the beak is turned from the stone and the male blade withdrawn; then the separated blades are turned toward the stone, which is seized and fixed.

If the stone be not detected during the introduction of the lithotrite, quiet is maintained for a few moments after the arrest of the instrument at the posterior wall of the bladder. Then the male blade is slowly withdrawn, with the beak upward, until quietly arrested by the neck of the bladder. It is then slowly returned to the former position, usually catching the stone *en route.* If the stone be not found at this time, withdraw the male blade as before, and with the beak at 45° to the right, close the blades again. Failing in this attempt, separate the blades and turn the beak to the left to 45° and close the instrument. If this manipulation fail, depress the handle of the instrument so as to raise the beak slightly from the floor of the bladder, and turn it to the right and left respectively, as need be, opening and closing the blades in each position in the same cautious manner. If the stone be small or the prostate be enlarged, the beak should be turned downward in the search. This is readily done by depressing the handle of the

instrument sufficiently to permit the reversed blade to sweep the floor of the bladder easily, without injuring the parts. The blades are then opened and closed at the various inferior aspects of the bladder, and in the same cautious manner as before.

Another manœuvre, which, in the case of small stones located behind the prostate, will often prove successful, consists in drawing the reversed beak outward until it nearly touches the prostate, and then separating the blades by pressing the female blade backward until it strikes against the posterior wall of the bladder, the male blade being held firmly in position; raise the handle until the female blade rests lightly upon the floor of the bladder, then draw it forward to join the male blade, lightly touching the floor in its course. If a stone lies in the line it will be touched, and, moreover, the mucous membrane will not be pinched. It is better that the blades be smooth and the beak be short in these reversed movements.

The Comments.—The movements of the instrument in searching should be slow, and punctuated with slight intervals, so that the stone will be dis-

Fig. 1557.—Showing the manner of holding the lithotrite when opening and shutting in the search for fragments.

turbed as little as possible by contact or the agitation of the surrounding fluids. Usually the female blade is held firmly in position, while the male blade is opened and closed carefully for the purpose seizing the stone. A gentle tap of the handle of

will sometimes cause a stone to fall within the grasp of the open blades. If practicable, the calculus should be crushed so fine at the first sitting as to prevent lodgment in the urethra of an impassable fragment. Forcible instrumental impingement on the neck of the bladder should be cautiously avoided at all times. Occasionally the stone may be so pressed against the neck of the bladder by the male blade as to prevent its being caught, unless the blade be turned to one side and cautiously insinuated between the stone and the organ. The brief though sage advice of Sir Henry Thompson, "Open; pause; close—that is all," establishes the safety of the procedure when cautiously practiced.

The crushing of the stone follows promptly the catching. The stone should be caught lightly and the blades be slowly fixed upon it to avoid its escape from the grasp in case it be hard or insecurely caught, as may happen if haste or vigor be exercised in such instances. When securely seized its dimensions should be noted, the beak turned upward and carried to the center of the bladder, as nearly as practicable, before crushing, in order that freedom of the mucous membrane be assured and that the fragments fall in a handy place for subsequent treatment with the least injury to the bladder wall. If the stone be soft the pressure of a steady turn of the screw is sufficient; if hard, a quick vigorous turn may be needed to crush it. In either instance, if quietly done, the fragments fall and lie close at hand, and can be caught and crushed by repeated opening and closing of the blades with the same deliberate care and manipulation that characterized the primary act. That is, the male blade should be withdrawn with the beak upward and axis of the instrument unchanged, then turned to the right or left and carefully closed, when, if a fragment be caught, the beak is again turned upward, away from the wall, and the fragment crushed. During the crushing the female blade must be held firmly and at an angle of 45° with the horizon, and remain entirely passive (Fig. 1557), and the blades should only be separated sufficiently to admit the stone between them. If the beak be not turned away from the stone before it is opened, the stone may be displaced by the separation of the blades.

Each sitting, if without anæsthesia, should not exceed five or ten minutes; with it, a sitting can be prolonged until an ordinary calculus is reduced to fragments, usually from ten to fifteen minutes. When the sitting is completed the blades must be screwed firmly together, so that the instrument may be withdrawn without injury to the urethra. The intervals of the crushing will depend upon the size of the stone, its hardness, and more frequently upon the effect of the crushing upon the patient. Inasmuch as the conditions differ greatly, it is impossible to lay down any absolute rules. The surgeon should not repeat the operation until the subsidence of the irritation produced by the previous attempt.

The Precautions.—The urethra should be sufficiently capacious to permit the wise use of the lithotrite, and the seizing and tearing of the mucous membrane of the bladder should be carefully avoided. If the membrane be caught the movement of the beak toward the center of the bladder will be hindered, and, too, the sensation of seizing a soft instead of a hard tissue may be noticed. However, the grasping of blood clots, pediculated growths,

and possibly soft stones when coated with mucus, may simulate mucous membrane seizure. The turning of the beak away from the bladder wall will eliminate these fallacies. If the patient be conscious, the seizure of the mucous membrane will be known quickly by his sensations. Hæmorrhage is rarely sufficiently severe to constitute a complication. Severe bleeding points to the presence of a vascular growth or a grave injury of the blad-
der or urethra. Not infrequently a congested mucous membrane, though ordinary care in the manipulation of crushing be employed, will cause a perplexing hæmorrhage. The presence of detritus at the borders of the blades, at the time of withdrawal, may damage the mucous membrane of the urethra. However, if they be firmly screwed together, with or without a sharp tap with an instrument, the importance of the fact is reduced to a minimum.

The Complications.—The blocking of the lithotrite in the crushing of a pasty stone may happen if the groove for the male blade do not extend to the lower end of the instrument. The author experienced once an embarrassing case of this kind, and knows of a similar one in the practice of a col-

FIG. 1559.—Fenestrated jaws.

FIG. 1558.—Thompson's lithotrite.

FIG. 1560.—Non-fenestrated jaws.

league. The non-fenestrated instrument may become blocked so as to prevent the proper closure of the blades and thwart a safe withdrawal from the bladder. Perineal or suprapubic cystotomy, with exposure of the beak and removal of the obstruction, followed by removal of the stone through the opening, is the solution of th⸱   If the beak of the instrument be broken, cystotomy offer⸱   ladder be torn through, and the fact be recognize⸱   he tear is indicated, the

same as in lithotomy (page 1416). If the deep urethra be ruptured, perineal section is called for. The lodgment in the urethra of a fragment of stone at the time of or immediately subsequent to the operation may cause much trouble, especially if it prevent the flow of urine.

The After-treatment.—After the completion of the sitting the patient is given an anodyne, and hot fomentations are applied to the abdomen, and he is caused to remain in the recumbent posture for at least twenty-four hours subsequent to the operation, even to the extent of lying on his side during micturition. If urethral fever or retention occur, or a mild cystitis supervene, the length of the time of confinement in bed and the treatment should conform to the requirements which these conditions impose.
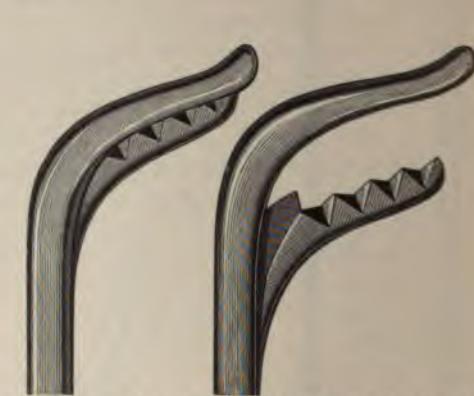
FIG. 1562.—Bigelow's non-fenestrated blades.

FIG. 1563.—Bigelow's fenestrated blade.

FIG. 1561.—Bigelow's lithotrite. *a, c.* Open, unlocked. *b.* Closed, locked.

FIG. 1564.—Keyes's modified blades.

The Comments.—Lithotrity is practiced much less than formerly, lithol-apaxy being done instead. The pain and perplexity incident to the block-
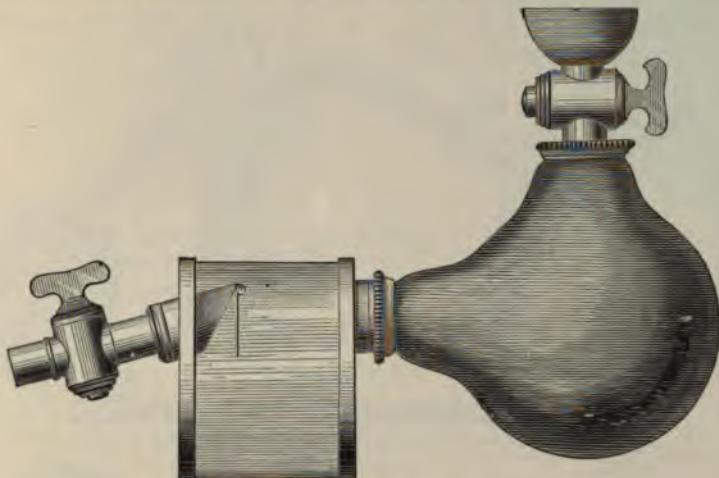
FIG. 1565.—Thompson's evacuator.

ing of the urethra by an escaping fragment, especially when large and angu-lar, and the leaving behind of a piece for future development of stone, are sequels to be anticipated in this operation no matter how carefully it may
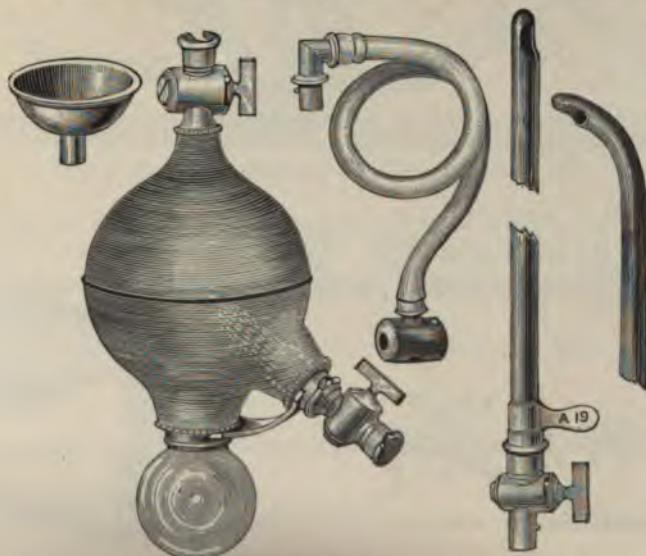
FIG. 1566.—Bigelow's evacuator.

be practiced. The   der by water, at the time
of crushing, wit   of the fragment by the

sudden and forcible outrush of the fluid, exposes the patient to the danger
of rupture of the organ—a fact which is emphasized by the reported hap-

Fig. 1567.—Otis's evacuator, ready for use.
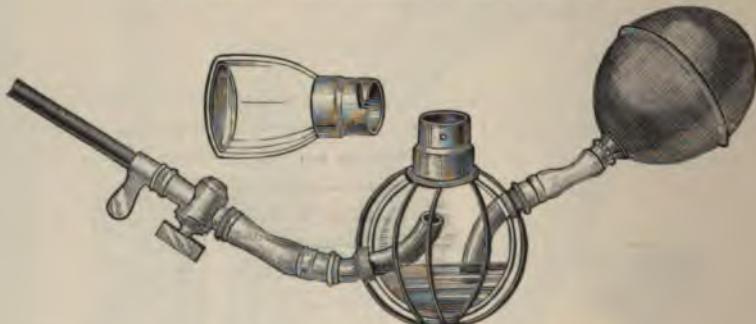
Fig. 1568.—Otis's evacuator, inverted.

penings of this accident from the stereotyped plan of the introduction of
water during the crushing process. At all events, only operators competent

Fig. 1569.—Chismore's evacuator.

to detect and crush the fragments so as to preclude these accid-
without some unavoidable reason, practice lithotrity.

The Results.—The general rate of mortality is about 11 per cent. The liability of retention in the bladder of one or more fragments exposes the patient to a comparatively prompt return of the trouble.

Litholapaxy (rapid lithotrity), or the crushing and washing out of a stone at a single sitting, has largely supplanted lithotrity.

The instruments usually employed in this procedure are the lithotrites of *Thompson* or *Bigelow*, as shown in Figs. 1558 to 1561, the latter being in quite common use. The blades of lithotrites differ in their grinding surfaces from a simple roughening to a well-marked denticulation. The blades of Bigelow's instrument present appearances peculiar to themselves (Figs. 1561 to 1563). The instrument used by *Keyes* is of a stronger pattern than is commonly employed, and is provided with a large wheel at the end that a greater force may be quickly applied. The blades are fenestrated (Fig. 1564), and are so constructed

Fig. 1570.—Bigelow's evacuating tubes.

that they will not clog. In the choice of an instrument for crushing, especially a pasty stone, one having an open heel (Figs. 1560 and 1564) should be selected. This plan of construction permits the male blade to dislodge from the corresponding groove of the female blade

Fig. 1571.—Warren's spiral-tipped evacuating tube.

Fig. 1572.—Keyes's straight evacuating tube and guide.

Fig. 1573.—Keyes's curved evacuating tube and guide.

obstructing detritus. Then e n pasty calculi may cause perplexing difment. Forbes has devised a lithotrite ble mechanism, and safe and effective all crushing operations the opera-

tor should possess lithotrites of two or three sizes and of different patterns and power, to enable him to comply with the demands of individual cases, as modified by the hardness and size of the stone, the size of the urethra, etc. For crushing large and hard stones a fenestrated blade should be employed. If the stone be small and friable, the blades may be roughened only, with the male blade much the smaller. A non-fenestrated or "scoop" lithotrite can be used to crush the smaller fragments. The larger and harder the concretion, the stronger should be the instrument employed. In addition to the instruments for crushing, the operator must be provided with an evacuator or washer. The Thompson washer is admirable (Fig. 1565), and the latest pattern of Bigelow leaves but little to be desired in this respect (Fig. 1566). Otis's washer (Figs. 1567 and 1568) is simple, cheap, and efficient; so also is Chismore's (Fig. 1569).

The evacuating tubes of Bigelow (Fig. 1570), or their modifications, complete the outfit. The spiral-tipped tube of Warren (Fig. 1571) and the straight, open-ended one of Keyes (Figs. 1572 and 1573) are thought to facilitate the discharge of the detritus, while, in the latter example especially, the lining membrane of the urethra is not exposed to injury from a fragment lodged in the eye of the instrument during its withdrawal from the bladder. The size of the tube commonly employed varies from 16 to 18, English scale. Those of different sizes and patterns should be at hand.

The preparatory treatment consists in alleviating all bad symptoms dependent upon the existence of the stone, and in preparing the urethra for receiving the instruments by increasing its size if necessary, and subduing any undue sensibility of it. The measures employed preparatory to lithotrity are, of course, of equal importance in this operation.

The Operation.—An assistant, whose only duty is to empty the washer and adjust it, should be provided. In other matters the technique differs in no essential regard from that of lithotrity up to the time of washing out the bladder.

The method of introduction of the lithotrite and the process of catching and crushing the stone are similar in this operation to the ordinary method, except that the crushing process is interrupted by the introduction of the evacuating catheter as soon as the stone is well broken, which may be within five or ten minutes after the introduction of the lithotrite, depending, of course, upon the success attending the efforts of the operator. A well-lubricated aseptic evacuating catheter is then passed down to the prostatic urethra, but not into the bladder, closely hugging the urethral roof and carefully avoiding the triangular ligament as it passes. The washer is then attached to the catheter at this situation to avoid the entrance of air into the bladder. Before attaching the washer it is filled with a warm boric-acid solution or with sterilized water. The air in the catheter while it is thus located will, if fluid be forced gently into the latter, pass upward through the fluid in the washer to the air trap above, from which it is excluded before the evacuating tube is carried on into the bladder. If now the elastic bulb be alternately slowly compressed and expanded, the changing current thus produced will wash the fragments from the bladder, and their weight will precipitate them into the glass receiver

beneath (Fig. 1574). After expansion of the bulb is complete, an interval
of a few seconds should elapse before pressure is again made, in order to
allow all of the fragments in the tube to drop into the receiver. If the out-
flow cease suddenly, the entrance of the tube is likely blocked with a large
fragment, or by the sucking in of the mucous membrane. If all the frag-
ments be not removed—which can be ascertained by the introduction of a
searcher, or known by the "click" of a fragment against the evacuating
catheter at the time of washing, and by the audiphone—the process of
crushing is again resorted to, and the resulting comminutions treated as
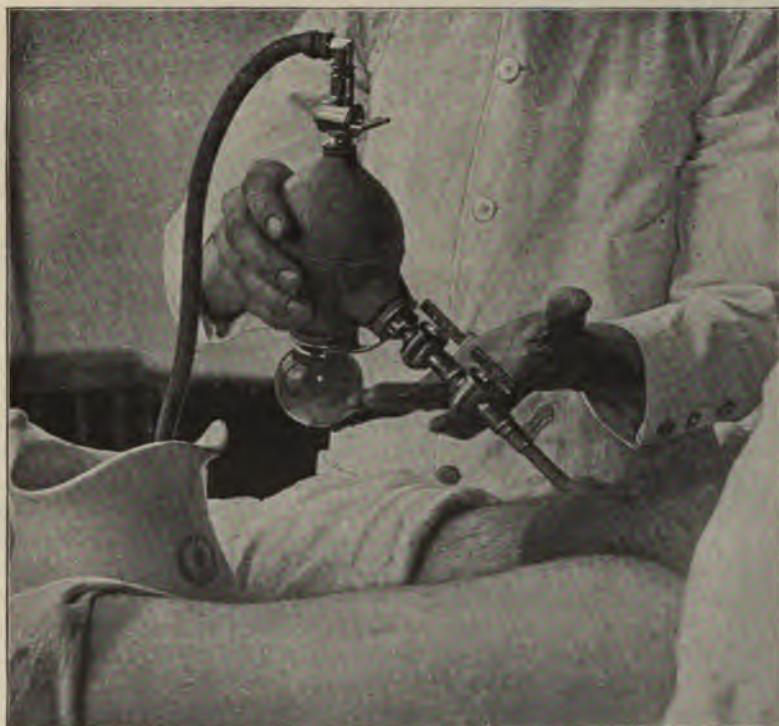
Fig. 1574.—Showing the manner of holding the bulb. The left hand holds the weight
while the right manipulates it.

before until the entire stone is removed. The last fragments not infre-
quently elude the grasp of the instrument, and, were it not that they can
be heard to strike the evacuating catheter when the water flows outward,
their existence might not be known. If the curved tube be used the beak
should be turned from side to side to present its eye to different aspects
of the bladder. The square-ended tube of Keyes (Fig. 1572) is passed just
beyond the neck of the bladder, and its external extremity is well lowered
between the thighs. The author has employed with seeming advantage an
evacuating catheter with an additional large eye at the convex surface.
With this arran͏͏ med easier to secure the final small frag-

ments than without it, especially if the bulb were very slowly manipulated. However, it is better sometimes to allow these fragments to remain until the patient has recovered from the operation, and then seek for them again, than to continue indefinitely the attempt to secure the last one at the first sitting. Small fragments that escape detection are not infrequently passed with the urine within four or five days after the operation.

The limit of time to which the first crushing may be prolonged is not an arbitrary one; an hour or two is not unusual, and even a longer time may be employed. However, an hour is a fair estimate of time to occupy in the common class of cases.

The Comments.—In profound anæsthesia with deep breathing, the current of the fluid should be the reverse of that of the respiratory current—i. e., running in with expiration, running out with inspiration. The opening of the evacuating catheter should be raised somewhat above the fragments, and suction should not be permitted until they are settled in place. The absence of the "click" during washing is the best proof of the withdrawal of all the fragments. Auscultation of the abdomen or instrument employed in the search will enable one to detect the faintest sound. A thudlike sound, attended with brief arrest of the flow, is suggestive of the indrawing at the eye of the catheter of the mucous membrane of the bladder.

The Precautions.—The entrance of air to the bladder during the washing out should be avoided, since its presence there causes a churning sound which obscures the click of small fragments and hinders a proper flushing of the viscus. The air can be removed by slow manipulation of the bulb with the end of the tube at the uppermost portion of the bladder. The presence during withdrawal of the catheter of a stone in the eye of the instrument may lacerate the urethra; therefore, a suspicion of such a fact calls for a clearing out of the instrument before its withdrawal. The fickleness of rubber goods emphasizes the wisdom of having two evacuators at places far removed from the base of surgical supplies, as the writer once had occasion to know. The passage of an evacuating catheter with a large eye along the urethra must be done cautiously, or the mucous membrane will be cut by the border of the eye. In fact, it is better to close the opening in advance with an obturator, which can be easily removed after the introduction, than to incur the danger of injury by omitting closure. The complications of crushing are stated under Lithotrity (page 1383).

The After-treatment.—After the operation the patient is kept quiet in bed and well wrapped; if retention occurs, it is relieved by a catheter. *Vide* Lithotrity.

The Sequels.—Litholapaxy has various sequels—rigors, retention of urine, cystitis, epididymitis, atony of the bladder, suppression of urine, etc. —each of which should be anticipated, and treated on general principles.

The Results.—Under ordinary circumstances the patient will be up and around at the end of a week or ten days. The rate of mortality is from $1\frac{1}{2}$ to 7 per cent, depending on the character of the case and the skill of the operator. Rarely a return of the stone is experienced except as the result of the initial cause. The results are better in women than in men.

Litholapaxy in Children.—Until quite recently it has been regarded as inexpedient and even positively dangerous by some to employ litholapaxy in children. But, inasmuch as nearly half the cases of calculi occur in children, and the outcome of the operation was so favorable in adults, the objectionable barrier of youth was quite promptly broken down by the favorable results of the operation when carefully practiced at the tender age by experienced hands. It was soon found that the diameter of the urethra in the youth could be as safely and suitably increased in size as in the adult. Also that the urethra and bladder of the young are very tolerant of instrumentation. While it is true that the mucous membranes of the young are more delicate than those of the old, still, the employment of extra caution, and the absence of concomitant complications of stone in children, together with their stronger inherent tendency to recovery, made the final outcome in them quite as good as in the most favorable adult cases. In children, instruments of a smaller caliber are required, and a due recognition of the higher position of the bladder is needed to safely secure the desired consummation in both crushing and cutting. But these anatomical peculiarities of youth make lithotomy all the more difficult. Added to this is the danger of irreparable injury of the seminal ducts in perineal lithotomy. The preparation of the patient and the general and special technique of the procedure is similar to that in adults. The complications are less frequent, though their avoidance and remedy is equally important.

The Results.—In 1,213 cases performed by eleven operators the average mortality was 2.22 per cent (White and Martin).

Combined Crushing and Evacuation.—The idea of the possible utility of such a combination occurred to us in 1884, after a somewhat annoying effort on our part to seize the "last fragment," the existence of which could be easily and quickly demonstrated by the characteristic click against the eye of the evacuating catheter during the washing-out process. We also recalled the fact that on other occasions the suction force of the washer had been temporarily arrested by the closure of the eye of the evacuating catheter by a fragment of calculus. In the construction the male blade of an ordinary lithotrite was modified to fit the anterior wall of the ordinary evacuating catheter, which is lined with a brass tube. The washer was easily connected with the instrument, as shown by the cut (Fig. 1575). It was not expected that this instrument would supplant the lithotrite. The idea was to crush the stone at the first introduction of the lithotrite as effectually as practicable, and then to introduce the combined instrument instead of the ordinary evacuating catheter. By means of this the detritus could be removed from the bladder, and such of the remaining fragments as were caught in the throat of the instrument could be crushed and likewise removed. It thus was possible to avoid the interchange of instruments incident to repeated crushings. With an assistant to manipulate the washer, the operator can devote his entire attention to crushing the fragments caught in the throat of the instrument.

Chismore has done much, indeed, by practice, precept, and ingenuity, to establish on a still stronger basis the operation of litholapaxy. He divides the cases practically into two classes: 1, those in which the prostate

gland is normal in size; 2, those in which it is enlarged, and remarks: "In the former the operator may confidently rely on clearing the bladder at one sitting; in the latter several crushings may be required, and the patient should be distinctly informed of that fact before the operation, in order that he may not, in his disappointment at not being entirely relieved at once, refuse to submit to further attempts."

Regarding the use of his outfit and the method of practice, he writes (September 12, 1900) us as follows:

"My essential instruments for litholapaxy are three: A combined crushing and evacuating lithotrite (Fig. 1576, *d*, with enlarged blades); an aspirator, very simple in construction (Figs. 1569 and 1576, *i*), without stopcocks and of such a shape as to fit the hand, and when coupled to the lithotrite it forms an excellent handle not interfering in the least with delicacy of touch; and an automatic hammer (Fig. 1576, *g*) that when vigorously applied to the lithotrite will crush the hardest stone. I have also modified Sir Henry Thompson's searcher, making the shaft to correspond in length, curve, and graduation marks with those of the lithotrite, shaping the external end of the handle so as to fit my aspirator, and providing it with a movable index.

"For the idea of an evacuating lithotrite I am indebted to you. Several of the older lithotrites had catheters in one or the other of the blades, but they were used solely for the purpose of increasing or diminishing the amount of fluid in the bladder during search or operation.

"The catheter in my instrument is in the male blade, the external end of which is made to fit my aspirator, so that I can avail myself of the to-and-fro current during aspiration to draw a stone or its fragments into the jaws—the first lithotrite, I believe, to make use of this principle.

FIG. 1575.—The author's combined instrument.

"The lithotrite is carefully prepared, by taking it apart, coating the shaft of the male blade with lanolin ointment containing ten grammes boric acid to the ounce, and putting the instrument together, working it back and forth until the ointment is evenly distributed between the tubes, making a packing impervious to air or water.

"A patient with normal prostate is placed on the operating table on his back, buttocks well down to the end, thighs moderately flexed, and the feet supported. A half drachm of a four-per-cent solution of cocain is thrown into the deep urethra by means of a Keyes syringe (Fig. 1576 a No. 13 Van Buren (*h*) sound is gently passed, and the size and co
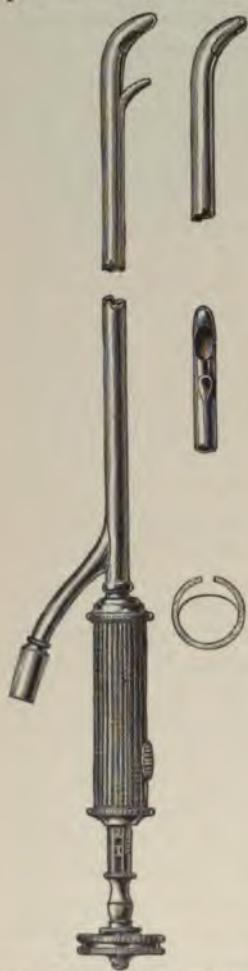
of the urethra noted. If a preliminary meatotomy is necessary it is done under cocain.

"Gently introduce the searcher (Fig. 1548) and empty the bladder even if the patient has just voided his urine. If this is not done there may be several ounces remaining and the operator be greatly misled thereby. The aspirator is filled with a warm solution of boric acid, coupled to the searcher, and about three fluid ounces injected. Careful, methodical search is then made over every part of the bladder that can be reached. In such cases the stone is usually found in the region of the base of the bladder to one side of the median line—most frequently to the right. A negative result should not always be taken as conclusive, especially if the patient is nervous and apprehensive. Manipulation under such circumstances should not be too prolonged. It is better to defer giving an opinion until a subsequent visit, when a better judgment can be formed. Several times it has happened to me to easily find a stone, and not always a small one at that, which has eluded search on the first trial. If a stone is found, note carefully its location—feel for its farthest border—and, having found it, set the index on the searcher at the meatus. Then strive to approximate its size by withdrawing the searcher until its nearest border is felt. Note the angle which the shaft of the searcher makes with the axis of the body. The bladder is once more emptied through the searcher, and from an ounce and a half to three ounces of warm four-per-cent solution of cocain is injected through it by means of a rubber tipped penis syringe. It is much more convenient to work in a small bladder than a large one; more than three fluid ounces are seldom required—less than that quantity is often better. While this is taking effect, the lithotrite and its appurtenances are placed within convenient reach, a large pan of warm solution of boric acid prepared, the aspirators (two) filled, and the tubes laid out.

"An assistant is needed to apply the pinion (Fig. 1576, a), when required, and to empty, refill, and hand the aspirators. But I have often done the operation alone. By this time—about five minutes after the injection of the cocain—the bladder is anæsthetized. The lithotrite is then properly warmed, anointed, and gently introduced. Too much care can not be taken in this step of the operation. Holding it lightly, gradually slip it along the urethra until the anterior triangular ligament is reached (Figs. 1583 and 1584). If there is obstruction wait patiently. Gently search along the face of the ligament for the urethral opening. Let it go its own way, do not try to force it, and presently spasm will relax, and it will slip in without pain or injury to the delicate and resentful structures. Once in the bladder, I carry the end of the closed lithotrite a little beyond the farthest border of the stone. Observe that the shaft is at the same angle with the axis of the body, as noted by the searcher. Open the instrument to the size of the stone, or a little more, reverse the beak to the locality of the stone, and, on closing the jaws, it is caught usually at the first trial. If failure attends, I seek again and again until success is attained. Should I not be able to readily grasp it in this manner, I open the jaws to the **that** the bladder will permit without force, gently push the **with** the female blade, at the same time depressing the

jaws by elevating the handle of the lithotrite, thus imparting to the viscus a V shape, with the open jaws of the instrument in the angle of the trough. Then, coupling on the aspirator (filled), compress the bulb and throw an ounce or more of its contents in. This creates a current which raises the stone up, when, smartly relaxing the bulb, the returning flow sucks the stone into the jaws. Sometimes these manœuvres have to be repeated many times before the stone is caught, varying the angle of the shaft, and lateralizing, or even reversing, the jaws. Each time fluid is withdrawn. Before again compressing the bulb it is used as a handle to the lithotrite. The jaws are gently closed to learn if the stone be within its grasp.

" Having secured the stone, and before grasping it tightly, move it in all directions to be sure you have not included any living tissues, and also to ascertain if there be more than one. If free, carry it to the center of the bladder and try to crush it by means of the hand cap (Fig. 1576, *b*). If too firm for that, the assistant inserts the pinion (*a*) and gradually puts on the force until the stone yields or again proves too strong. In this case the assistant holds it as firmly as possible with the pinion while the operator removes the hand cap and fixes the automatic hammer (*g*). With the hammer in the hollow of the right hand he makes firm pressure in a line with the shaft of the lithotrite. This pushes the piston a little inward and ' sets it.' Then with the first and second fingers of the same hand he brings the lugs smartly home, which releases the hammer and delivers the stroke. He repeats the manœuvres as often as needed, and it will be a tough stone, indeed, that does not yield to the shattering blows. During this procedure the left hand grasps the fluted handle of the female blade of the lithotrite, controls the position of the jaws within the bladder, and also furnishes the needed counter-resistance to the force of the hand cap (*b*), pinion (*a*), or hammer (*g*). Practically the hammer will seldom be needed.

" Having broken the stone, the fragments are much easier dealt with, since they gravitate to the locality originally occupied by the stone, where they can be readily found.

" If the stone is small, the aspirator will remove the fragments through the lithotrite as fast as it is crushed. If it is a large one, it is better to remove the lithotrite from time to time and introduce as large a tube as will pass without undue tension, and, with the aspirator, wash the *débris* out through it. If the detritus be impacted in the blades or lumen of the instrument the disengager (*c*) is introduced and the obstacle is dislodged.

" During this time the patient should have suffered but moderate pain. If pain becomes troublesome, open the stopcock in the lithotrite, let out the contents of the bladder, and, without hesitation, inject one and a half to three ounces of fresh cocain solution. I have frequently kept in the bladder a four-per-cent solution for more than an hour, and, on occasions, over three hours, without toxic effect. When the whole of the stone is removed a few bulbs of borated solution are thrown in and allowed to escape, for the purpose of removing the cocain, taking care not to distend the bladder. The patient may then dress and go home, with directions to remain in bed until the soreness and irritation have passed away, to save all urine passed for inspection, and to send for medical aid in case of chill or pain.
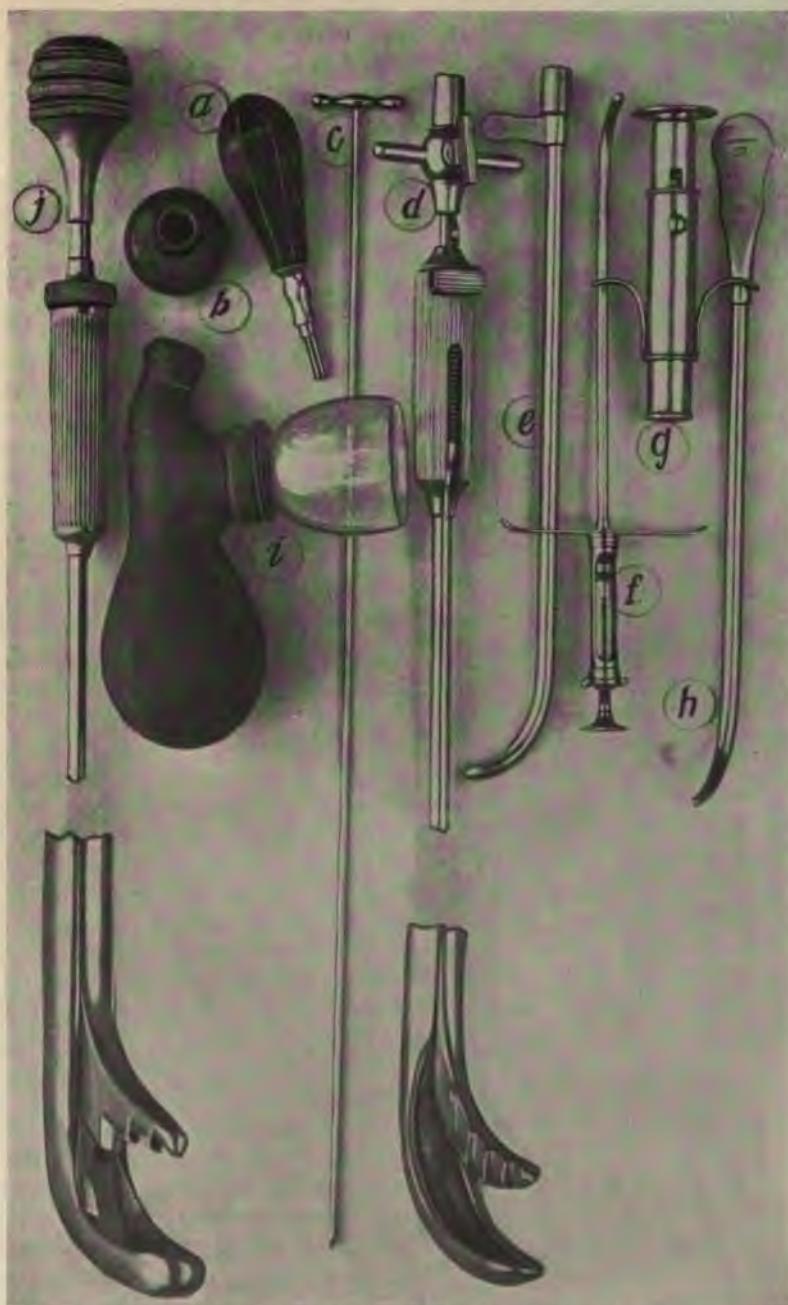
FIG. 1576.—Instruments employed by Chismore in litholapaxy. Also Forbes's lithotrite.

a. Pinion to lithotrite. b. Cap for hand pressure. c. Detritus dislodger. d. Chismore's lithotrite with magnified blades. e. Evacuating tube. f. Keyes's syringe. g. Automatic hammer. h. Curved steel sound. i. Chismore's washer, also Fig. 1569. j. Forbes's lithotrite with magnified blades.

"*Special Precautions.*—If the beak of the lithotrite is reversed, the operator should always bear in mind the fact that the line of the reflection of the recto-vesical fold of the peritonæum (Figs. 1583 and 1610) fixes, in a measure, that portion of the bladder to which it is attached. Below and above this transverse line the jaws of the instrument will easily push the walls of the viscus before them, when, if closed, a fold of the bladder is almost surely included in the bite. A knowledge of this fact, together with the easily recognized 'feel,' will serve to prevent injury from this source. If both jaws happen to be below the vesico-rectal fold, on attempting to open the instrument a false sense of sacculation is the result.

"*The After-treatment.*—Little need be said of after-treatment. When the whole of the stone is removed there is rarely any trouble. Should any fragments be left too large to pass the urethra they will give notice of their presence by pain and frequency of micturition, and the urine will continue cloudy with pus and mucus. I have found the sensations of patients very reliable as to a remaining piece. When they declare that they 'feel a piece' there is nearly always one present, and it should be sought for as soon as irritation from previous operation has subsided. An attack of urethral fever may come on at the first voiding of urine, especially if the deep urethra has been stretched much during the operation, but it subsides for the most part during the first twenty-four hours. A little morphin and quinine is all that is required.

"Small fragments become slippery with a coating of pus and mucus, and are voided with but little suffering. Often the action of the aspirator is so thorough that not a single grain of calculus is left. When a small fragment is suspected it is well to let the patient, when the bladder is full, stand upright while a full-sized litholapaxy catheter is gently passed. A small piece or pieces may often be got rid of by this simple method. Such cases are usually up and about in two or three days. I have never had a case of chronic cystitis follow the complete removal of a stone when the prostate was normal, nor have I yet had a fatal result, or any severe complication, follow a crushing operation in this class of cases.

"*In cases where the prostate gland is enlarged* and catheter life is begun, the proceeding is the same, save that the patient is plainly told that several sittings may be required to free his bladder from stone. Where the mass of the hypertrophied prostate encroaches upon the bladder, it removes a considerable area from the direct command of the lithotrite, and pieces may lodge there in such a way that prolonged manipulation will not secure them. In view of the fact that the urethra must be regularly traversed by the catheter at short intervals after the operation, I seize, crush, and remove as much as I can without creating too much disturbance, and defer the removal of the rest until the irritation caused by instrumentation has subsided. It is in these cases that the current through the lithotrite comes into play to best advantage, making the pieces hunt the instrument instead of the instrument hunting the pieces.

"*The Results.*—I do the greater number of the operations on my office table—often at a first visit. I have been using my lithotrite sixteen years; have operated on one hundred and twenty-one cases.

deaths within a month of the time of operation. An autopsy in each leaves no doubt that the practice had nothing to do with the fatal results in two cases, and that the third might possibly have been saved by lithotomy. Many of the cases were in a most pitiable condition—old, worn with pain, marked degeneration of important organs, kidneys, liver, and heart."

Perineal Lithotrity with Litholapaxy.—A stone may be crushed through an opening in the perinæum. Perineal lithotrity has as yet been rarely adopted as a primary method of treatment, but rather as an expedient to facilitate the removal of a stone too large to be extracted through the incision made for the purpose of a simple lithotomy. It has been advocated (perineal litholapaxy) as a substitute for lithotomy in large stones, because the crushing and the use of the washing apparatus can be substituted for the necessary incision through the deeper parts. Still, the withdrawal of an ordinary-sized stone can hardly compare in point of danger to the repeated introduction of instruments and the necessary prolongation of the operation of crushing through an open wound, especially in the hands of the inexperienced. However, it is, without doubt, an expedient which should be more frequently adopted, particularly for the removal of large stones through an opening too small to admit of their safe withdrawal.

Dolbeau systematized perineal lithotrity and crushing for the treatment of large stones.

The Operation.—Make an incision through the perinæum as in median lithotomy (page 1412), after which the dilatation is divided into three steps, the dilator of Dolbeau being employed (Fig. 1577). *The first step* consists in the dilatation of the tissues down to the groove in the staff (Fig.

FIG. 1577.—Dolbeau's dilator.

1578); *the second*, the dilatation of the tissues nearly through the neck of the bladder (Fig. 1579); *the third*, the withdrawal of the staff and the carrying of the dilator sufficiently to thoroughly dilate the neck of the bladder when expanded (Fig. 1580).

"The dilatation in all the steps must be done carefully and in accordance

FIG. 1578.—Dolbeau's method, first step.

with the resistance encountered. The prostate and the neck of the bladder can be dilated one inch without danger. After it is completed a lithoclast (Fig. 1581) of suitable size is introduced and the stone fragmented, after which it comes away with the urine. A small reverse current (Fig. 1593) of warm aseptic and carbolized water thrown into the bladder can be used to wash the fragments out. Dolbeau's shield (Fig. 1582) for protection of the soft parts during crushing should be employed, especially in severe and protracted cases.

Reginald Harrison, after much experience, expresses the belief that the introduction through the prostate of a small tapering gorget (Fig. 1493, *d*) (Teale's, Fig. 1493), followed by dilatation with the index finger, is a safer and more satisfactory method of entrance to the bladder in this operation than the use of the Dolbeau dilator, as the latter is liable to inflict serious injury. Also he advises the use of crushing forceps with blades resembling those of a lithotrite, with a cutting rib between them, and the handles provided with a screw for strong leverage purposes.
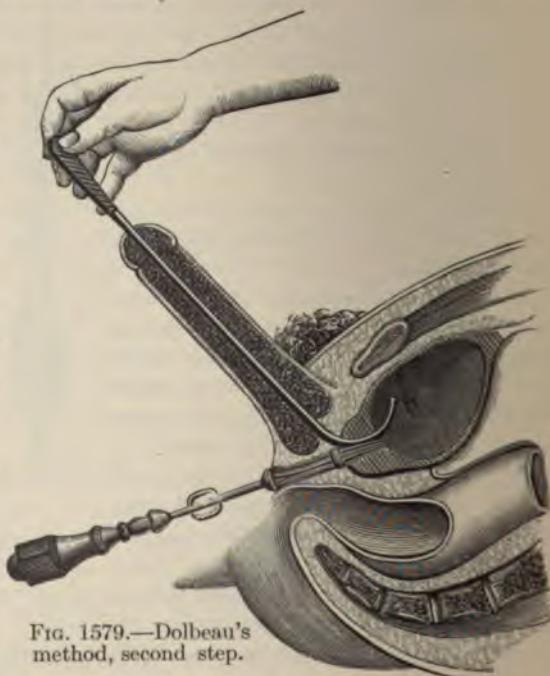
FIG. 1579.—Dolbeau's method, second step.

The fragments are removed by evacuating catheters of the size of the perineal wound—about the size of the index finger—and directly by the use of forceps.

Harrison regards the operation favorably for the following reasons: " 1. It enables the operator to crush and evacuate large stones in a short space of time. 2. It is attended with very little risk to life as compared with other operations where cutting is done, such as lateral or suprapubic lithotomy, and is well adapted to old and feeble subjects. 3. It permits the operator to wash out the bladder and any pouches connected with it more effectually than by the urethra, as the route is shorter and the evacuating catheters are of much larger caliber. 4. The surgeon can usually ascertain, either by exploration with the fingers or by introduction of the forceps into the bladder, that the viscus is cleansed of all *débris*. 5. It

Fig. 1580.—Dolbeau's method, third step.

enables the surgeon to deal with certain forms of prostatic outgrowth and obstruction, complicated with atony of the bladder, in such a way as to secure not only the removal of the stone, but the restoration of the function of micturition. 6. By the subsequent introduction and temporary retention of a soft-rubber drainage tube, states of cystitis due to retention of urine in pouches and depressions in the bladder wall are either entirely cured or are permanently improved. To lock up unhealthy ammoniacal urine in a bladder that can not properly empty itself, after a lithotrity, is to court the formation or recurrence of phosphatic stone. Hence it is well suited to some cases of recurrent calculus."

He regards it well adapted to cases of stone complicated with deep stricture, as then both can be treated at the same time. It lessens the risk of the performance of lithotrity in the presence of a permanently damaged urethra.

The Results.—The results are eminently satisfactory, much better than

are secured by other methods in similar cases. Harrison reported 14 cases in 1894; all successful.

Lithotrity in the female.—The absence of the prostate body and the shorter and larger urethra of the female combine to secure a more complete emptying of the bladder, and also lessen the liability to the formation of vesical calculi. A stone in the female bladder can not be grasped with the
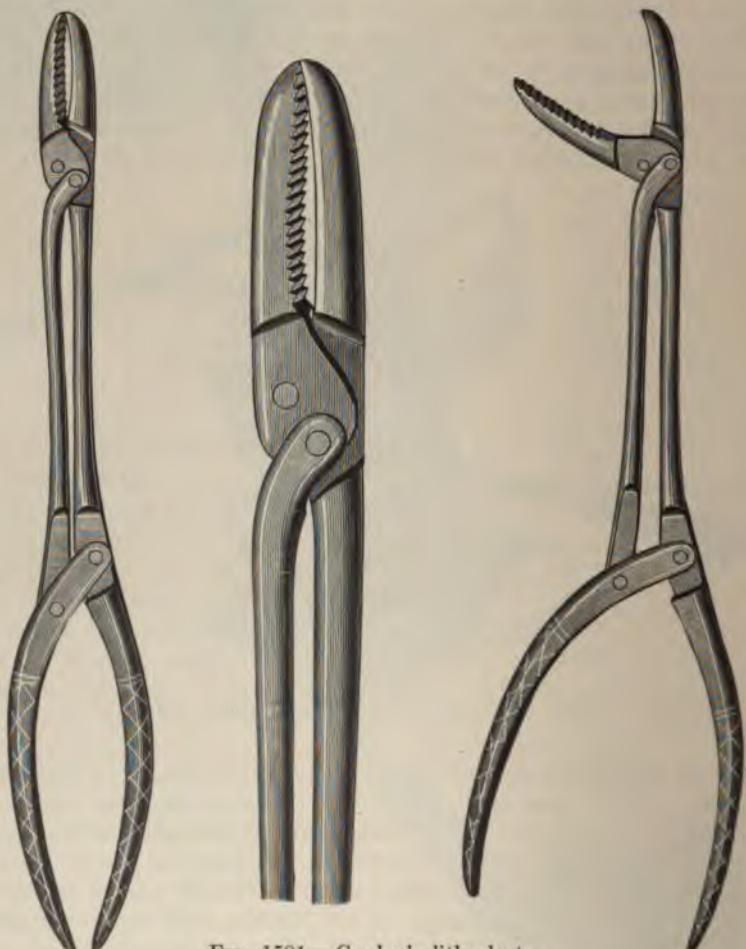
Fig. 1581.—Gouley's lithoclasts.

same facility as can one in the male, owing to the difference in the normal shape and surroundings of the bladder and to the pathological modifications to which its cavity is subjected, due to its connections with the uterus and vagina, and the physiological and pathological variations caused by child-bearing and its sequels. The greater liability to a sacculated base requires that the instrument be reversed more frequently than in the sterner sex. Because of the presence of the uterus, the posterior wall of the bladder is

more irregular and flat than that of the male, and the fragments do not gravitate to the same situation; instead, they are found lower down at the vaginal aspect, and require that the lithotrite be held almost vertically in order to grasp them, rather than at the angle of 45° as in the male. It is sometimes necessary to raise the vaginal septum with the finger so that the stone may be caught. The operation can, however, be readily performed, and, aside from the variations in the manœuvres necessary to catch the stone, differs but little from that in the male.

Evacuating apparatus can be satisfactorily utilized in these cases, and should be employed when practicable. A short, straight evacuating catheter is the best for use in these cases. Encysted stones and large hard ones should be dealt with by suprapubic lithotomy.

Lithotomy.—Lithotomy is the operation for the removal of stone from the bladder by cutting.

The accepted varieties of perineal incision in this operation are the lateral, median, bilateral, and medio-bilateral incisions. The suprapubic incision, variously modified, is now in common use.

The Anatomical Points.—The perinæum proper is a triangular-shaped space, the apex corresponding to the center of the pubic arch, the base to a line drawn transversely between the anterior portions of the tuber ischii, and the sides limited by the rami of the pubes and ischium. In the adult male the base of the triangle is from two to three and a half inches in breadth, and the sides from three to three and a half inches in length. The dimensions of the base are of especial interest, since the

FIG. 1582.—Dolbeau's shield to protect the walls of the wound during crushing.

narrower it is the less oblique lateral incisions can be made. The perinæum is divided into two equal parts by the median rhaphe, the anatomy of each being similar. The left half is the more important, on account of its relation to lateral lithotomy. The bulb of the urethra and the central fibrous point are on the median line, the latter being located about half an inch in front of the anus and just behind the bulb. The internal pudic artery runs along the inner surface of the tuber ischium (Figs. 186, vol. i, 1529, and 1530), giving off hæmorrhoidal branches and farther along the superficial perineal branches and artery of the bulb. The relation of these several vessels to the cutting operation for stone should be carefully considered before operation is begun. The fasciæ of the perinæum is of great anatomical importance in connection with the course taken by extravasated urine (Fig. 1583). If the extravasation happen between the anterior and posterior layers (*a, a*) of the triangular ligament the membranous urethra is at fault, and the extravasation is limited at first to the deep triangular space; if the fluid lie just in front of this ligament, it promptly extends over the scrotum

91*

and penis on to the abdomen, but is limited behind and at the sides to the base and borders of the perinæum; it does not extend on to the thighs.
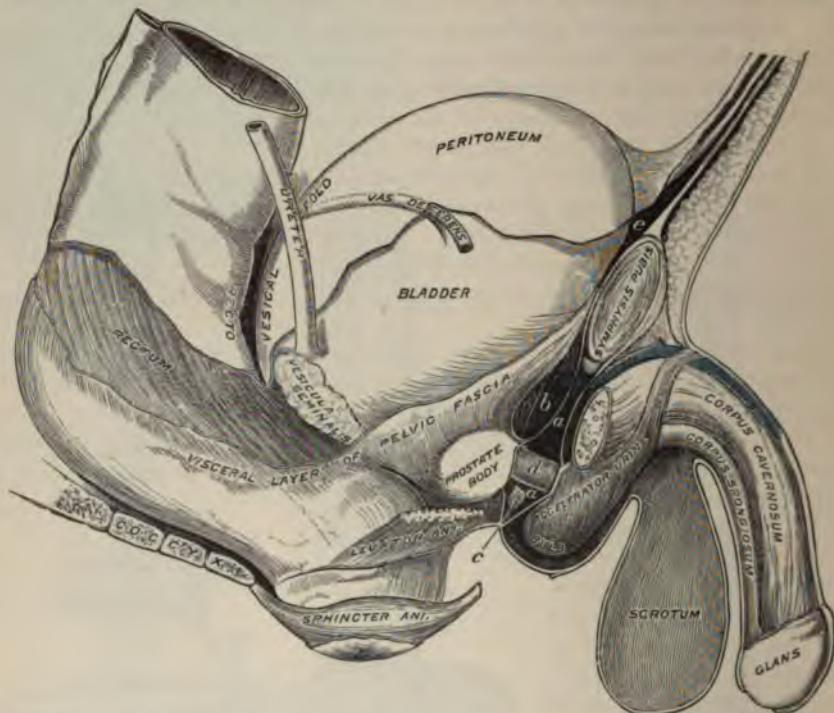
FIG. 1583.—Deep surgical anatomy of perinæum, bladder, etc. *a, a.* Space between the superficial and deep layers of triangular ligament. *b.* Space posterior to deep layer of triangular ligament, continuous with Retzius's space. *c.* Cowper's gland. *d.* Membranous portion of urethra. *e.* Retzius's space.

If the fluid lie in front of the superficial perineal fascia, it then extends beneath the superficial fascia of the perinæum in all directions. Of course, after suppuration occurs the distinctive importance of the fascial arrangement promptly disappears. In a thin perinæum the base of the triangular ligament can be felt on deep pressure just in front of the anus. This is an important perineal landmark, as the membranous urethra lies about three quarters of an inch above this point, and about the same distance below the subpubic ligament, as it passes between the layers of the triangular ligament (Fig. 1584). The prostate body is placed in front of the bladder a around the beginning of the The shape, dimensions,

FIG. 1584.—The anterior layer of triangular ligament, showing opening for membranous portion of urethra.

acteristics, and anatomical relation of it to the bladder and urethra exercise an important influence on the surgical technique of perineal approach to the bladder, and they ought to be carefully studied in an accredited anatomical work before attempting operation. The bladder is about two inches and a half to three inches from the surface of the perinæum, with the patient in the lithotomy position.

Lateral Lithotomy.—Lateral lithotomy is employed when the stone is too large to be easily removed through the dilated prostate. *The special*
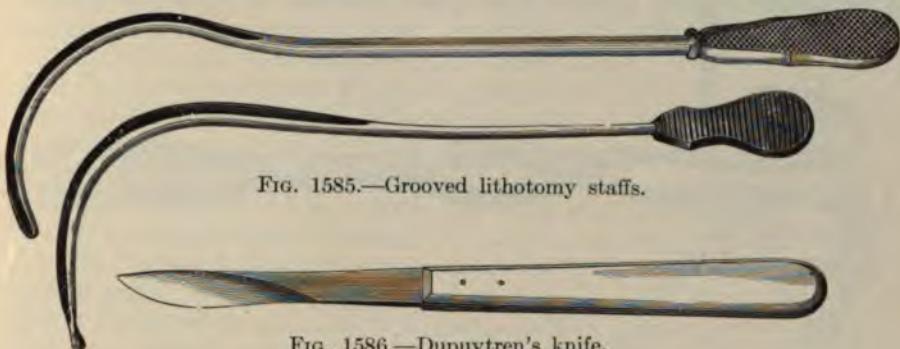
Fig. 1585.—Grooved lithotomy staffs.

Fig. 1586.—Dupuytren's knife.
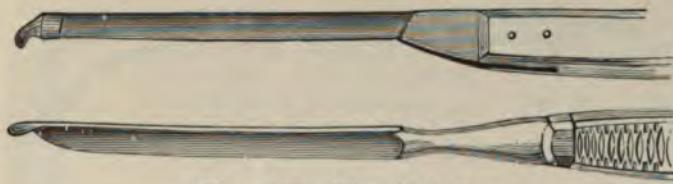
Fig. 1587.—Blizard's knife.

Fig. 1588.—Blunt gorget.

Fig. 1589.—Scoop and conductor.

instruments are a staff of suitable size, with the proper curve and a deep groove upon its convexity which approaches the right lateral aspect as it nears the extremity of the beak (Fig. 1585); a bistoury, with a stout blade and handle, a solid (Fig. 1586) shank, a sharp point, and a cutting edge of about two inches in length; a probe-pointed knife—the one devised by Blizard (Fig. 1587) being the best—and, if the perinæum be deep, due to ity or other cause, the gorget may be selected (Fig. 1588); a combined nd conductor is serviceable (Fig. 1589); forceps of various sizes and

shapes to seize the stone, one of which should be arranged with crossed handles to avoid stretching the parts about the neck of the bladder when the stone is grasped (Figs. 1590 and 1591). It is well to be provided with a small lithoclast for the purpose of breaking stones too large to be extracted with safety, a scoop to dislodge the remaining fragments of stone (Fig. 1592), and a syringe to wash from the bladder any small fragments that may remain (Fig. 1593). Davidson's syringe can be used, but is less satisfactory than one designed for the purpose. The chemise or shirted and the air-bag cannula (Figs. 1594, 1595, and 1596) are useful to control hæmorrhage. At least five assistants should be present. To one of these

FIG. 1590.—Straight forceps.

FIG. 1591.—Curved lithotomy forceps.

FIG. 1592.—Dolbeau's lithoclast.

the staff should be intrusted; the lower limbs may be controlled by two others, either with or without the limbs being confined by the anklets (Fig. 1597). The hands and feet may be bandaged together satisfactorily for the purpose. Of the remaining assistants, one should attend the instruments and the other the sponges, etc. The more modern device for separating the lower limbs and exposing the perinæum will be found of great service (Fig. 1598). Forcipressure, retractors, ligatures, wipers, and drainage tubes, should be at hand.

The Preliminary Steps to the Operation.—Rest in bed for two or three days before operation, or, at the least, long enough to ascertain the condition of the kidneys, as indicated by the amount and character of the urine,

is very important. The cleansing of the bladder
with an aseptic fluid should be practiced during
this time if the urine be offensive or much vesical
irritation be present.

Shave and disinfect the parts, empty the rec-
tum with an enema, administer an anæsthetic,
draw the patient down to the edge of the table,
and control the lower extremities by bandaging
them to the upper, or give each one in charge of
an assistant.

The staff is introduced and the stone found—a
fact that should be verified by others present. If
the stone be not detected the staff should be with-
drawn, and its presence and location determined
by the searcher. These points must likewise be
confirmed by others. If the stone be not found at
all the operation must be deferred.

The principal assistant, who holds the staff,
should satisfy himself that the sound is in con-
tact with the stone, although it is not necessary
that it be pressed against it during the operation.
The holder of the staff should stand at the
patient's left and hug it firmly beneath the pubes
with the right hand, while the
integument of the perinæum
is made tense by drawing up
the scrotum with the left.

Fig. 1593.—Van Buren's
débris syringe.

Fig. 1594

mise
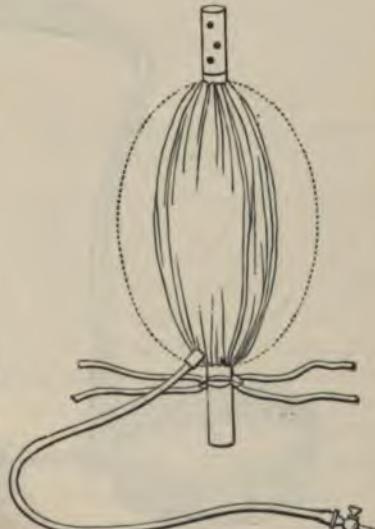
Fig. 1596.—Browne's air tampon and
cannula.

The convexity of the staff should be easily felt in the perinæum. If the perinæum be thin the groove may be distinctly defined with the finger. Some surgeons have advised that the staff be pressed against the perinæum, instead of the pubes, that the outline may be the better defined. However, it is a matter of little importance which course is taken, as long as the pubes are hugged by the instrument while the incision is being made into the bladder. The surgeon should sit upon a low stool, and, before beginning the incision, carefully map out the location of the bulb and the point where the incision is to begin, also determine the outlines of the rami and tuber ischii. He then introduces the index finger of the left hand into the rectum, locates the apex of the prostate, and determines its relation to the sound. The finger is withdrawn, thoroughly cleansed, and the groove in the staff again located.

Fig. 1597.—Pritchard's anklets and wristlets.

The Operation.—The incision is commenced a little to the left (one third of an inch) of the median rhaphe, from an inch and a quarter to an inch and a half in front of the anus (Fig. 1607, *b*). The point of the knife is made to enter the groove at the second or third cut, being guided there by

Fig. 1598.—Clover's crutch to hold the legs (Fig. 1607), with strap to go over the shoulders.

the nail of the index finger of the left hand. The perineal incision is made obliquely downward from three to three and a half inches in length, *midway between the tuber ischii and the verge of the anus*. It is deep above and should be shallow below. The urethra is then freely opened, and the probe-pointed bistoury substituted for the scalpel; or the blunt extremity of the Blizard (Fig. 1587) or another suitable knife is engaged in the groove, when the surgeon, taking the handle of the staff in the left hand, draws it downward somewhat, and then, holding it firmly, carries the point of the knife along the groove toward the bladder in the line of the perineal incision, depressing its handle slightly to correspond to the curve of the staff. As soon as the end of the knife is stopped by the termination of the end of the groove in the staff its handle is depressed, the edge turned outward still more, and the deep tissues severed from within outward by its withdrawal, care being taken to make the incision through the prostate more horizontal than that of the perinæum (Fig. 1599). The flow of urine which follows assures the operator of successful entrance to the bladder.

It is recommended to press the point of the scalpel firmly against the groove in the staff with the right hand, seize the staff with the left, depress the handle of the staff and the knife at the same time, to the same extent, and thus convert them for the moment into one instrument which is pushed into the bladder. This plan is often practiced, and when carefully done will prevent the escape of the point of the knife from the groove. It is more

FIG. 1599.—Lateral incision of prostate and perinæum.

difficult, however, to properly lateralize the knife in its passage through the prostate in this than by the former method; besides, it is a less elegant act. *The asepticized* index finger of the left hand is now passed carefully into the bladder along the staff, which is then withdrawn. The neck of the bladder is dilated by the finger, the stone reached, and its diameter estimated, if it has not been done before. The closed forceps (Fig. 1590 or 1591) is now passed into the bladder along the finger as it is withdrawn, and the stone carefully sought for and grasped in the short diameter, if possible. If one blade of the opened forceps be pressed upon the floor of the bladder, the stone will often roll promptly within its grasp. However this may be, unusual caution must be employed in the manipulation, so as not to bruise the contracted walls of the viscus. If the stone be grasped in its long axis it should be dropped and the position corrected by the finger carried into   in the direction of the

long axis of the stone may sometimes be accomplished by carrying two fingers into the rectum, separating and pressing them upward against the bladder, thereby compressing its sides and creating a furrow running antero-posteriorly into which the stone will drop correspondingly. When properly grasped the stone is withdrawn by steady traction made in the axis of the floor of the pelvis and in the line of the perineal incision. As soon as the calculus is removed, its surface is examined for facets, which will indicate the presence of one or more calculi still in the bladder. Having removed the calculus, irrigate the bladder with warm aseptic fluid to remove all blood clots and whatever detritus may be present. If there be earthy matter in the bladder it may be necessary that it be removed with a scoop.

Lateral Lithotomy in Children.—Lateral lithotomy in children is modified somewhat on account of their relatively different normal anatomical state.

The Anatomical Points.—The pelvis is small; the bladder is high in the pelvic cavity, freely movable and insecurely fixed; the urethra is small and thin, hence the more readily torn; the prostate is undeveloped and the neck of the bladder correspondingly exposed to division, which, if too extended, may involve the pelvic fascia. However, the perinæum is thin and the bulb diminutive, therefore the staff can be easily felt. The high position of the bladder enables the surgeon to control it well by abdominal and rectal palpation.

The Precautions.—Note that the instruments are of proper size and that gentleness of manipulation be practiced. A too forcible effort at introduction of the fingers may push the bladder upward in front of them or tear the prostate. A forcible dilatation of the neck of the bladder is therefore to be avoided, and relatively free incision made instead.

The operation in the child differs in no important regard from that in the adult, except that the incision into the bladder is made relatively freer and the vesical wound is dilated carefully with dressing forceps instead of with the fingers, at the outset. If greater capacity be needed the forceps are removed and a small probe is introduced as a guide to the finger, which is then carefully insinuated along the probe into the bladder. First the little, then the index finger can be introduced if required. The stone is removed in the usual manner with forceps or a scoop, aided by the finger in the bladder or rectum.

The General Precautions.—In lithotomy the incision should be carefully laid out and cautiously made to avoid cutting the bulb and its artery above, or the rectum and internal pudic below. The point of the cutting instrument must be surely lodged and kept in the groove of the staff, or it will go astray, doing great damage and misleading the surgeon. The handle of the knife should be depressed as the point moves forward in the groove, or the point will leave the staff. If the handle be depressed too much, the point of the knife will be fixed in the groove and further advance prevented until the direction is rectified. If the staff enter a false passage unnoticed the surgeon is misled, the incision misplaced, and perhaps irretrievable injury done. The careless holding of the staff often perplexes

and may confuse and mislead the operator. The staff should not be withdrawn until the finger or a probe have been passed along the groove into the bladder, otherwise the lines of incision may be lost and much difficulty experienced and care required to find it again. If the incision be too small the tissues will be torn by the extraction of the stone; room can be gained by dilatation or by repeated incisions made in the line of the first one, or at the opposite side. If the incision be made too far posteriorly the ejaculatory ducts will be cut. A too free incision of the neck of the bladder will cause urinary infiltration of the pelvic fascia. Too great traction on a stone will tear the neck of the bladder, perhaps beyond the limits of the prostate, causing infiltration and sepsis. A lateral incision of the neck of the bladder in the adult should be limited to the extent of the prostate (three quarters of an inch.

The General Remarks.—In lithotomy if the stone be encysted it is very difficult and often impracticable to remove it. It may be possible to grasp an exposed portion with forceps with or without division of the confining structure, and in either instance great care and judgment must be exercised. An irregular contraction of the bladder may cause entanglement of a stone. But pressure upon the fundus, supplemented with digital touch and the employment of large forceps, will meet the contingency. Vigorous traction on the short axis of a long stone pulls the bladder downward so as to expose the prostate at the perineal wound if continued. Lateral movements with traction, when slowly made, will facilitate the removal of a calculus without contributive danger. If a stone be too large for safe removal it should be crushed and removed piecemeal.

The Complications.—The complications can be rationally divided into the concomitant and consequent varieties.

A deep perinæum due to corpulency, enlargement of the prostate, the presence of tumors in the bladder, and post-prostatic encystment of the
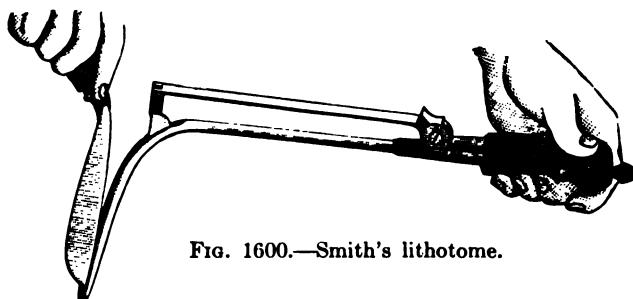
Fig. 1600.—Smith's lithotome.

stone, preventing the grasping of the calculus, are not infrequent concomitant complications.

Among the *consequent complications* are wounding of the bulb, the rectum, or the bladder. The latter viscus may be severely wounded by puncture with the staff, the slipping of the knife from the groove, etc. Laparotomy and closure of the wound should be promr‾
cases. If the incision be carried too far in

the pudic artery may be cut respectively, and if begun too far from the anus or at the median line the bulb will suffer. If the penis be drawn forward on the staff, and the staff be raised against the pubic arch as the urethra is being opened and the incision extended, the bulb is drawn away from the course of the knife. Breaking of the stone seems a trivial complication, but may be very annoying before the fragments are all removed. The inability to find the stone after making the incision is perplexing, which may depend on a false passage, a hidden calculus or its unobserved escape with the first gush of urine, or possibly on a mistaken diagnosis. Incontinence and retention sometimes occur. Hæmorrhage at the time, or shortly after the operation, is a troublesome and sometimes fatal complication. If arterial hæmorrhage occur, catch and tie the bleeding point if practicable; the bleeding may be checked by ice pressure or by the use of a hot-water-bag tampon; if these be inadequate for the purpose, forcipressure may be applied to the bleeding point and allowed to remain for twenty-four hours. The tying in of a tenaculum or the use of acupressure may be feasible. Venous hæmorrhage can be controlled by the chemise catheter (Figs. 1595 and 1596), the air-bag tampon, or by some other similar expedient. Prostatic phlebitis followed by thrombosis and sepsis sometimes follow, either originating from the primary wound or caused by the steps essential to the arrest of severe, deep-seated hæmorrhage. Suppression of urine due to kidney disease is a danger not to be disregarded.

While the preceding technique of the operation is that usually employed, still there are instrumental modifications which, in the opinion of some, may lessen the dangers of the operation in inexperienced hands. The instrument devised some years ago by Smith, of Baltimore, and successfully employed by him and others (Fig. 1600) is worthy of mention. It

FIG. 1601.—Dupuytren's   FIG. 1602.—Hutchinson's
double lithotome.   single lithotome.

consists of a rectangular staff with a well-rounded angle, deeply grooved on its horizontal portion, and provided with an indicator attached to the shaft by means of a hinge. The indicator is likewise rectangular, and terminates in a lance-shaped blade. The indicator can be adjusted by sliding it up and down the staff; or various sizes of the instrument may be employed to meet individual differences. The staff is introduced and held by an assistant in the usual manner, and the cutting extremity of the indicator is applied to the median line and pushed through the tissues until it lodges in the groove of the staff. The probe-pointed gorget is then passed into the groove and lodged in the channel on the staff, along which a cut is made into the bladder. A probe-pointed bistoury may be substituted for the gorget. *The use of the double and single lithotomes* (Figs. 1601 and 1602) were advocated formerly more frequently than at the present time. But then as now, how-
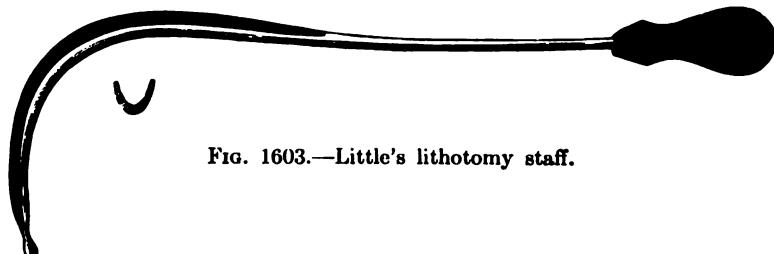
FIG. 1603.—Little's lithotomy staff.
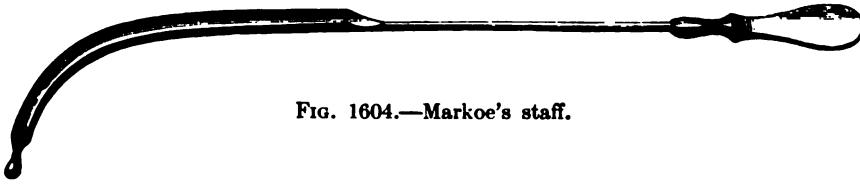
FIG. 1604.—Markoe's staff.
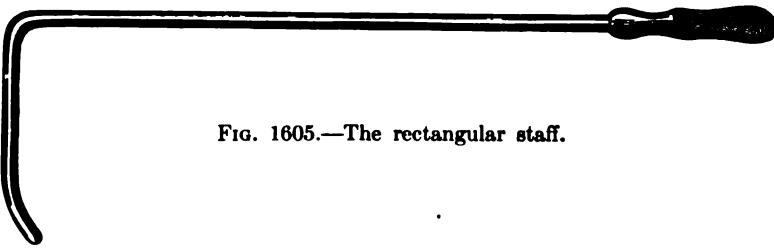
FIG. 1605.—The rectangular staff.

ever, their advocates were small in number as compared with the adherents of the use of the scalpel and grooved staff.

The After-treatment.—After the operation place the patient in bed with a rubber cloth beneath the hips, separated from the body by cloths and sponges, to collect the urine and indicate the occurrence of hæmorrhage. The temporary introduction of a catheter or drainage tube into the bladder through the wound in the perinæum is practiced ofte

patient has suffered from cystitis with infected urine. Under these circumstances the tube should not be omitted for three or four days, and even longer if the discharge be offensive or a tendency to retention be present. If the tube become blocked the obstruction should be removed by a probe, an aseptic feather, or a stream of water, and perhaps be removed entirely and cleansed. If a long silver probe be carried through the tube and allowed to remain, after removal it will be of great service in returning the tube to the former posi-
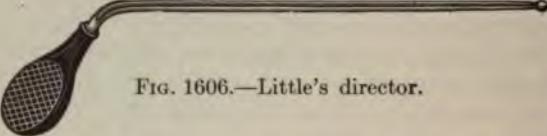
FIG. 1606.—Little's director.

tion. Give light and stimulating diet, alkaline drinks, and treat all sequelæ on general principles.

The Results.—The rate of mortality varies from 6 to 10 per cent.

Median Lithotomy.—Median lithotomy is applicable to cases having one or more small stones half an inch or so in diameter, and in advancing puberty for prostatic calculi and for small calculi with offensive cystitis. In this method there is less danger from hæmorrhage, much better control of the urine from the first, and the wound heals rapidly. If the stone be larger than is anticipated, the temptation to use undue violence during the extraction is great. It is claimed that this method may be followed by stricture of the urethra, and also that the mouths of the seminal ducts are more likely to be injured by extraction of the stone than in the other methods. However, the exposure of the ducts to injury by cutting is eliminated in this method.

The general precautions to be employed in all forms of lithotomy are mentioned fully in connection with the lateral operation (page 1403 *et seq.*).

The instruments are the staff, director, and knife. The staffs vary somewhat in the shape and depth of the grooves. The ones devised by Little (Fig. 1603) and Markoe (Fig. 1604) leave nothing to be desired. The rectangular variety (Fig. 1605) can be used in lieu of the curved one, although it has been infrequently employed in this country. The director devised by Little is an admirable instrument (Fig. 1606), but is by no means alone essential to successful operation. A stout, straight, sharp bistoury, doubleedged at the point for making the perineal incision, makes the especial outfit complete.

The Operation.—Confine the patient in the lithotomy position (Fig. 1607); introduce the staff, placing the end of the beak in contact with the stone; pass the left index finger into the rectum and locate the apex of the prostate just where the staff enters it; introduce the point of the knife into the median line of the perinæum half an inch in front of the anus (*a*), with the long cutting edge uppermost, and push it carefully upward to the apex of the prostate, guided by the finger in the rectum, into the groove of the staff. The knife is advanced sufficiently toward the bladder to nick the apex of the prostate, after which it is carried forward to divide the membranous portion of the urethra. The external incision should be from an inch and a quarter to an inch and a half in length, care being taken

to avoid the bulb of the urethra. The director is then passed into the bladder along the staff, and the neck of the bladder moderately dilated by separating the two from each other. The staff is then withdrawn, and the asepticized index finger of the left hand is carried through the neck of the bladder along the director with a semirotary motion to complete the dilatation. The forceps is then introduced, the stone caught at its short diameter, and removed by steady, gradual traction, which may be accompanied by rocking movements, but never by a rotation of the instrument on its long axis while grasping the stone.

Various instruments have been devised to dilate the prostate in this and other methods calling for the procedure, all of which when carefully employed answer the purpose well, but are by no means essential to a safe performance of the operation. After the removal of the stone, arrest hæmorrhage, seek for any remaining calculi, and otherwise treat the patient as indicated in the lateral operation.

The Remarks.—The small size of the perineal opening in children may interfere with the proper removal of the calculus. Care in the avoidance of
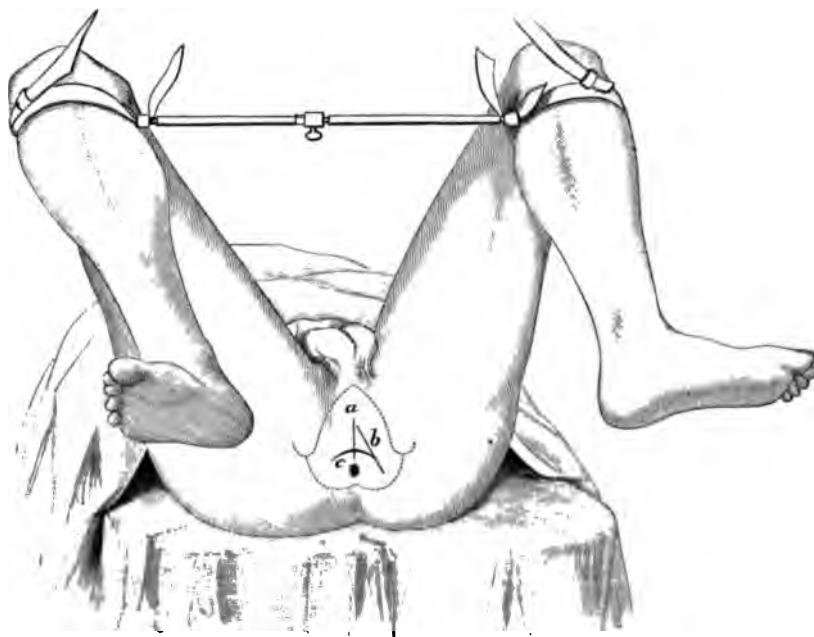
FIG. 1607.—Lines of incision in perineal lithotomy, showing Clover's apparatus applied. *a.* Incision in median lithotomy. *b.* Incision in lateral lithotomy. *c.* Incision in bilateral lithotomy.

injury of the bulb and the rectum is especially needful in this operation. Inasmuch as the operation is suited only for the removal of small stones, which usually can be better done by lithotr^... is now comparatively rarely practiced.

The Results.—The death ra^

The Bilateral Lithotomy.—The preliminary preparations, the precautions, and general arrangements in this are similar to those necessary in the other methods. The special instruments are the grooved staff and the bisector, so intimately associated with the name of the late Prof. James R. Wood (Fig. 1608), or the lithotome of Dupuytren or Briggs (Figs. 1601 and 1609).

The Operation.—Make a semilunar incision across the perinæum, three fourths of an inch in front of the anus, beginning midway between the anus and the tuberosity of the right side, and terminating at a similar point on the opposite side (Fig. 1607, *c*). The convexity of the cut is directed forward. The several tissues are divided down to the membranous urethra, which is opened, and the beak of the instrument is inserted in such a manner as to cause the beveled edges of the bisector to be uppermost. After moving the beak backward and forward, to be certain that it is well lodged in the groove, it is then firmly pressed against the groove of the staff, and, with the staff held firmly, it is carried into the bladder. The staff and cutting instrument may be, practically, converted into a single instrument by pressing them firmly together and carrying them inward at the same time, being careful to depress simultaneously the handle of each to the same degree.

The Precautions.—The cutting instrument may be carried behind the bladder if any tissues exist between the groove and its probe-pointed extremity, or its handle be not depressed so as to keep the beak in the groove of the staff. The anterior wall of the rectum may be cut while making the crescentic incision, if directed too much downward. This accident can be avoided by inserting the index finger of the left hand into the bowel when
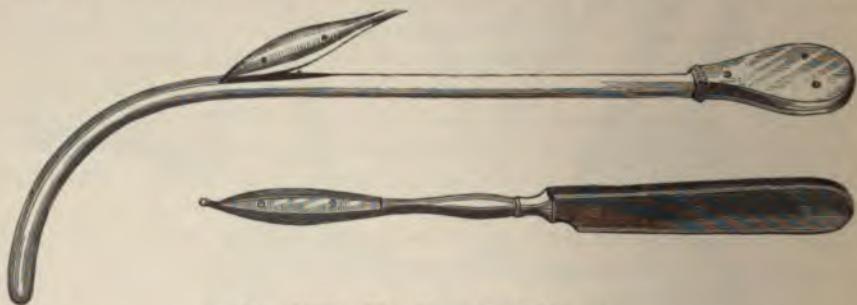
Fig. 1608.—Wood's staff and bisector.

the primary incision is being made, and drawing the anterior wall backward while the cut is being completed.

The results obtained by this method in the hands of Dr. Wood were equal to, if not better than, those previously given in connection with the other methods of cutting for stone.

Nélaton's Modification.—Nélaton modified the first step of the bilateral method with the view of lessening the danger of cutting the bulb and the wall of the rectum. He introduced the left index finger into the rectum, placed the end of it against the apex of the prostate, and steadied the ante-

rior border of the anus with the thumb of the same hand. He then made a semilunar incision in front of the anus, the extremities of which were four fifths of an inch from the anus at either side, and the greatest convexity three fifths of an inch from it. The dissection was continued, layer by layer—the wall of the rectum and the bulb being carefully avoided—until the membranous urethra was reached and opened, and the cutting instrument introduced. The same object was accomplished through a transverse incision an inch and a quarter in length, with its center located three fifths of an inch in front of the anus.

The Medio-lateral Lithotomy.—This method was introduced by *Buchanan*, of Glasgow.

The necessary instruments are a rectangular staff with a broad groove at the left side, and a narrow, straight knife with a long cutting edge. The
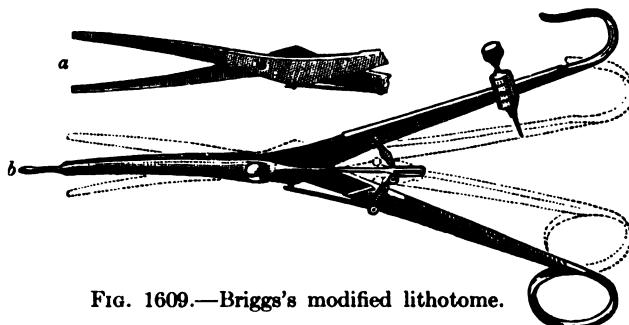
Fig. 1609.—Briggs's modified lithotome.

staff is introduced, and the prominent staff angle adjusted to correspond to the muco-cutaneous junction on the anterior verge of the anus in the median line.

The staff is firmly held with the handle inclined toward the abdomen, and the overlying tissues are penetrated by the knife, held horizontally and with the edge turned to the left, until the groove in the staff is reached; then the knife is pushed forward into the bladder upon the staff. As it is withdrawn, an incision three fourths of an inch long is made downward and outward toward the fore part of the tuber ischii. This incision is completed by being continued directly downward about half an inch. If necessary it can be extended.

The Results.—A little over 10 per cent are reported to have died from operation by this method.

The Medio-bilateral Lithotomy.—The medio-bilateral operation was brought to the notice of the profession by Civiale, and afterward was championed in this country by Briggs, of Nashville. The staff for the median method is introduced with the patient placed in the usual position; the rectum is drawn backward by the finger, and an incision is made through the median line into the staff an inch and a half in length, beginning about half an inch in front of the anus.

The lithotome (Fig. 1609, *a*) is then introduced into the groove, carried into the bladder, the blades are separated half an inch, limited by the pointed slide on the handle, and the instrument is withdrawn, thus dividing

the prostate, and enlarging the wound on either side a quarter of an inch throughout. The wound is then dilated and the stone removed in the usual manner. If too large it may be crushed. The writer modified Briggs's instrument somewhat by introducing an independent guiding stem which steadies the cutting blades during the withdrawal of the instrument from the bladder (Fig. 1609, *b*).

The Results.—Briggs reported the mortality as 1 in 37 cases, which is certainly an astonishing result.

Suprapubic Lithotomy.—The suprapubic or high operation was done near the middle of the sixteenth century. Since this time it has found favor at several epochs, and is now again being strongly advocated and quite generally practiced. The various relapses of the method depended, without doubt, more upon the determination of its exponents to make it an exclusive operation than upon its own intrinsic defects.

The following conditions call for the employment of this method: great prostatic hypertrophy; inability to extract the stone through the perinæum on account of its size; encysted stone; large stone with a contracted bladder surrounding it firmly; impermeability of the urethra. The method
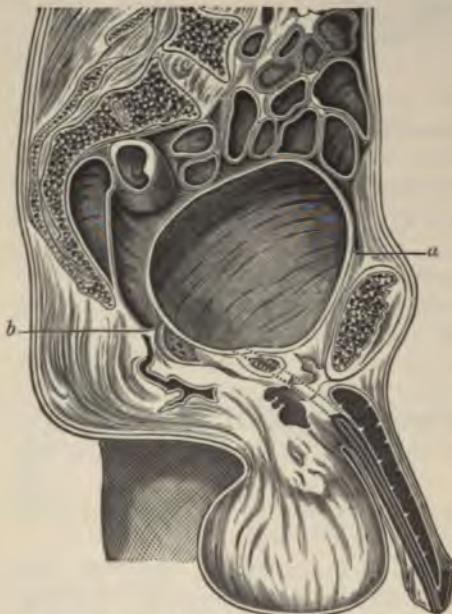
Fig. 1610.—Cut from frozen section. Bladder contains ten fluid ounces. *a*. Prevesical fold of peritonæum. *b*. Retrovesical peritoneal fold.

Fig. 1611.—Bladder distended with twenty fluid ounces. *a* and *b*. Folds of peritonæum.

permits of a complete inspection of the bladder, obviates all danger of injury of the structures of the neck of the organ, and establishes the w in a favorable site for cleanliness.

The Anatomical Points.—The median line of the body at this si

can be determined by measurement and by palpation. The symphysis pubis and the suprapubic notch are infallible bony guides to the lower limit of the median line, and can be easily located, except in cases with marked adipose deposit. The linea alba at this situation is frequently too indis-
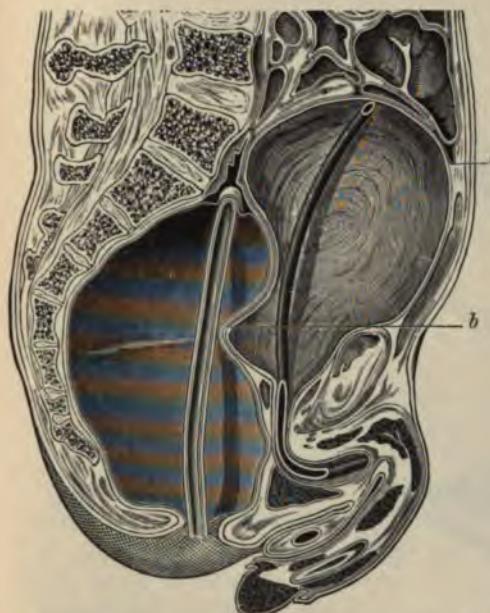
Fig. 1612.—Bladder contains six and a half fluid ounces. Rectum distended with fifteen fluid ounces. *a* and *b* mark the peritoneal folds.
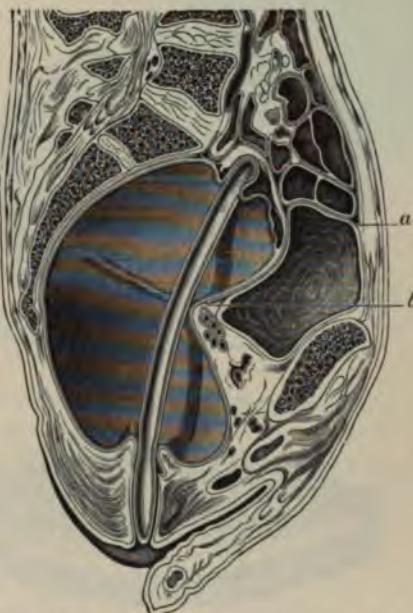
Fig. 1613.—Bladder contains fourteen fluid ounces. Rectum distended with sixteen fluid ounces. *a* and *b*. Folds of peritonæum.

tinct to be relied upon as a guide. The pyramidal muscles located beneath the sheath of the rectus should not be mistaken for the rectus. The direction and marked development of their fibers, and their superficial location should make their recognition easy. The suprapubic notch can, at this time, be readily felt, and will indicate the lower limit of the median line positively. The separation of the borders of the pyramidal muscles and the lower extremities of the recti abdominis and the divided borders of the transversalis fascia—lying immediately beneath the latter—from each other, will open directly into the anterior limit of the space of Retzius, otherwise known as the prevesical space (Fig. 1583, *c*, *b*). The prevesical space lies between the bladder and the pubis, and contains a variable amount of fatty tissue resting on the bladder and continuous with the pelvic and subperitoneal tissues. The bladder here is not covered with peritonæum, and is not approachable from without in an undistended state, except with great danger of injury to the fold of peritonæum reflected upon it from the a⸺   bladder is known by its pinklike color, oval outline, ⸺   the appearance of the outer muscular fibers. If ⸺   occur the use of the hypodermic syringe will

decide the question. The space of Retzius is of great importance, as its extent affords opportunity for wide urinary infiltration and connective-tissue sloughing. And especially is this true if rough and prolonged disturbance of its contents be practiced. If the bladder and rectum be empty the apex of the bladder and the anterior peritoneal fold are below the upper margin of the pubis in all instances. As the apex of the organ is raised above the pubis the peritoneal fold and the contiguous intestines are correspondingly elevated, and the prevesical space is brought into position for safer operative attack (Figs. 1610 and 1611). The base of the bladder is raised upward by rectal distention irrespective of distention of the bladder itself (Fig. 1612). But the apex of the bladder is not elevated by rectal distention unless the bladder also be more or less distended (Fig. 1613). Dis-

Fig. 1614.—Rubber bag for distention of rectum.

tention of the bladder alone increases its height in the abdominal cavity and raises the peritoneal fold proportionately to the degree of the vesical distention; rectal distention at this time produces a correspondingly similar result. The higher position and the greater mobility of the bladder, in children, permit it to rise, when distended, to a much safer position for operation than in the adult. However, a well-distended normal
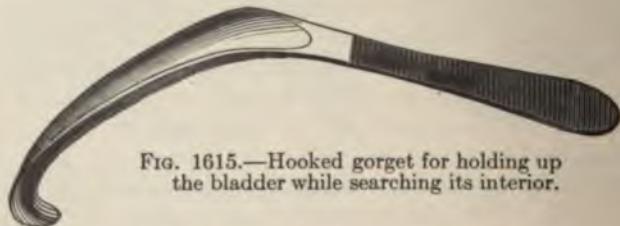
Fig. 1615.—Hooked gorget for holding up the bladder while searching its interior.

adult bladder is safely placed for operation if needed care be exercised. But, when supplemented with rectal distention, all common operative dangers are eliminated (Fig. 1614).

The Preparation of the Patient.—The preparation of the pati

as the mucous and cutaneous surfaces are concerned, has been indicated already in the operation of cystotomy, lithotomy, etc. In this instance it is essential that the bladder be thoroughly cleansed frequently before, and again at the time of operation, to remove as far as possible from contact with the wound surfaces the infecting influences that often attend the changes incident to the presence of vesical calculus.

The Operation.—Place the patient on the back; induce profound anæsthesia; wash out the bladder with a warm solution of boric acid; leave the catheter in the bladder. Smear with vaseline, fold

Fig. 1616.—Cushing's suture.

and introduce the rectal bag well above the sphincters, causing it to lie in the hollow of the sacrum. Introduce into the rectal bag ten or twelve ounces of warm water and clamp the tube. Introduce into the bladder ten or fifteen ounces of a warm solution of boric acid, carefully noting the ascent of the bladder and arresting the flow as soon as the organ is suitably distended.

Fig. 1617.—Brenner's double purse-string suture.
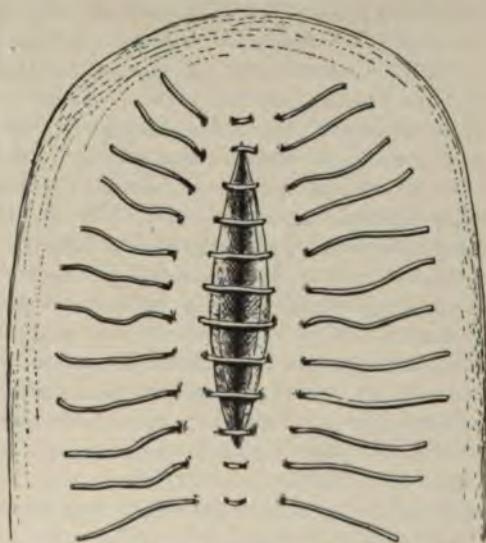
Fig. 1618.—MacCormac's method of placing interrupted sutures.

Withdraw the catheter and close the penis with a rubber band, or clamp the r and apply the band as before.
  bladder is then exposed and opened in the manner described under

"suprapubic cystotomy" (page 1310). Extract the stone carefully (Fig.
1619), examine for another, and for the presence of *débris*; remove the
constriction from the penis and wash out the bladder through the urethra,
if washing be needed. Whether or not the bladder shall be sutured and the
abdominal wound closed, is a question that has given rise to much discus-
sion and is not yet settled. In children, and in adults with healthy blad-
ders and limited adipose deposit, immediate union can be safely practiced,
provided the prevesical space be drained through a small opening at the
most dependent part of the abdominal wound. And even then frequent,
careful, and intelligent scrutiny should be exercised to detect the first mani-
festation of the escape of urine. In every instance of partial or complete
closure, a limited surface at either side of the vesical wound should be
freshened and so united with interrupted sutures of silk or chromicized
catgut as to secure coaptation of the raw surfaces. The Cushing (Fig.
1616), or Halsted (Fig. 919), or double purse-string (Fig. 1617), or the
interrupted suture (Fig. 1618) are employed, according to the practice of
the operator. The suture should never pass through the mucous lining of
the organ, and a round needle should be used in the sewing. While there
are many instances of complete closure recorded by experienced surgeons,
both with and without interrupted or continuous drainage through the penis
or perinæum for two or three days, followed by perfect results, yet it never-
theless happens that in the majority of instances in which complete pri-
mary closure is made, prompt and permanent union does not take place.
Therefore, if there be any doubt regarding the proper course to pursue in
this respect, the visceral wound should not be entirely closed, and suitable
drainage should be established. In case immediate union be sought for,
drainage of the abdominal wound, as already stated, should be practiced,
and the bladder relieved with a catheter at regular intervals, if continuous
drainage be not employed. *Rydygier* proposed and practiced an intraperito-
neal method of operation as follows: He thoroughly cleansed the bladder
and the field of operation, inserted and retained in the organ a large cath-
eter, exposed the anterior wall of the bladder in the usual manner—but
more extensively opening the peritoneal cavity—drew up and temporarily
fixed the bladder to the borders of the abdominal wound by sewing the two
tissues together so as to exclude the peritoneal cavity completely from the
entrance of urine, opened the bladder, extracted the stone, removed the
temporary sutures, and closed the openings in the bladder and abdomen at
once, in the usual manner of closing wounds of serous membranes. This
method affords abundant space of entrance to the bladder, permits its wall
to be drawn upward into, and possibly outside, the wound, and assures one
of prompt and firm union because of the apposition of serous surfaces.
Harrington strongly favors this plan for the reasons already stated.

The *Complications.*—Rupture of the bladder or of the rectum is a com-
plication of great significance, which should be carefully guarded against by
attention to the exciting and predisposing influences that occasion it. Sep-
tic infiltration of the space of Retzius is a dangerous and often a fatal com-
plication. Free incisions at dependent parts to secure good drainage and
the free use of antiseptic solutions are the needed measures of treatment in

such cases. Rough handling and infection of the connective tissue of the prevesical space by urinary infiltration or infection are the common causes of this condition. In order to prevent these complications in infected cases, *Senn* advises that the operation be divided into two stages. At first the bladder is exposed and the wound packed with gauze for four or five days, until the spaces are closed by granulation, when the visceral incision is made with cocain anæsthesia in the usual manner. Suppression of urine from kidney disease is often provoked by suprapubic lithotomy, the same as by other operations on the bladder.

The Precautions.—If the rectum be diseased the bag should not be employed. If the bladder be greatly diseased, dilatation should be practiced cautiously and perhaps dispensed with entirely, and a perineal operation performed. The introduction of twenty-three ounces of fluid has caused rupture of a healthy adult rectum; the injection of four ounces has caused rupture of a diseased adult bladder. Rupture will rarely happen if not more than eight or ten ounces are introduced into the bladder and rectum respectively. In either instance injection should cease when undue resistance is experienced. Adhesion of the peritonæum to the pubis may prevent the ascent of the bladder. In feeble and relaxed subjects the bladder rises from out of the pelvis freer and farther than in those of dissimilar states. It is essential, therefore, to comprehend the possibility of the presence of contraindicating and restraining influences in distending the viscera, or rupture may ensue. If the visceral and abdominal wounds are closed at once, it is wise to test the line of union of the former by moderate distention of the organ with air or fluid before the latter is closed. For, if a defect be found, it can then be repaired before closure of the abdominal wound, and in the presence of doubtful integrity of the line of union the abdominal wound can be drained.

The Remarks.—Whether the bladder or the rectum be distended first is a matter of no special importance in ordinary cases. However, when a fear of the lack of structural integrity of the bladder or of the bowel be present, the impaired viscus should be favored, and the requirement of the healthy one correspondingly increased. Since the distended rectal bag obstructs the circulation of the bladder, thereby congesting its field of operation, the later in the course of the procedure the bag is distended the better it is, in this regard. Still, as the bleeding is not severe and can be promptly checked by ordinary means, by a removal of the bag and opening the bladder, the bleeding is not entitled to special significance, except in rare instances. In children and thin adult subjects, rectal distention need not be employed, especially if the patient be placed in Trendelenburg's position. This posture is especially serviceable in the instances of a pendulous abdomen, and when the light can thus be utilized to the best advantage. The finger is employed to detect the stone before the forceps is introduced, and the opening is then made of the necessary size to admit of the extraction of the stone without injury to the tissues. Some operators distend the bladder with air instead of fluid, claiming that air, being more compressible than fluid, is less liable to **cause rupture (Bristow).** *Brown* commends the use of air, and advises tha⁺   **ly** cleansed through

93

a rubber catheter, which is then fastened in place and retained for the purpose of the introduction of air. The apparatus employed in the act is not disconnected at first, but is left temporarily attached, so that on exposure of the fascia additional inflation will cause the organ to approach still nearer to the surface. Finally, the catheter is clamped to prevent the escape of air, and the pump or syringe is removed. Brown commends the bicycle air pump for the purpose, and states that each in-and-out action of the piston is about equal in effect to the introduction of an ounce of water. He likewise recommends that the rectal distention be dispensed with when air is employed in the bladder. Either of the agents, when discreetly employed, meets the indications, and is not a source of especial danger. In the absence of suitable forceps the stone may be removed from the bladder, especially if it be shallow, by means of interlocked fingers (Fig. 1619).

The After-treatment.—If the bladder be closed completely, the after-treatment relates to vigilant attention to forestall infiltration, rather than to medical measures. If the bladder be not closed entirely, the bed should be protected by waterproof sheets and with sponges; the exposed parts of the body thoroughly anointed with vaseline; the wound sprinkled with iodoform; the pelvis well separated from the bedclothes by a large cradle, both for convenience and ventilation. The urine should be absorbed at the wound with numerous sponges and absorbent cotton applied to the part, and changed perhaps two or three times an hour. Of course, the siphon drainage, already described (page 1321 *et seq.*), should be employed, and, when efficient, will relieve the patient and the attendants of much trouble. However, any form of drainage is often fickle, on account of the uncertainty of action contingent on the manner of adjustment and the co-operation of the patient. The wound and the bladder should be thoroughly cleansed when needed, and the patient caused to sit up as soon as practicable. The wound in the bladder usually closes in from two to four weeks. Bandaging and strapping interfere with drainage and do not hasten repair.
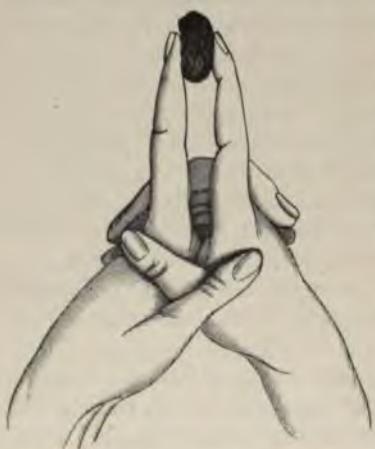
Fig. 1619.—Removal of the stone from shallow bladder by interlocked fingers.

The Results.—The death rate is about 13 per cent in practice at large, but is much less in the hands of those skilled in the selection and employment of the method.

The Choice of Operation.—The choice of operation in the various cases of stone in the bladder is not always easy to determine. In a general way the determining reasons of choice are indicated already in connection with the respective operations. It seems proper to add in this connection the statistics of White, relating to the influence of age on the outcome of operative methods.

STERILIZED OIL.

ELECTRIC LIGHT.
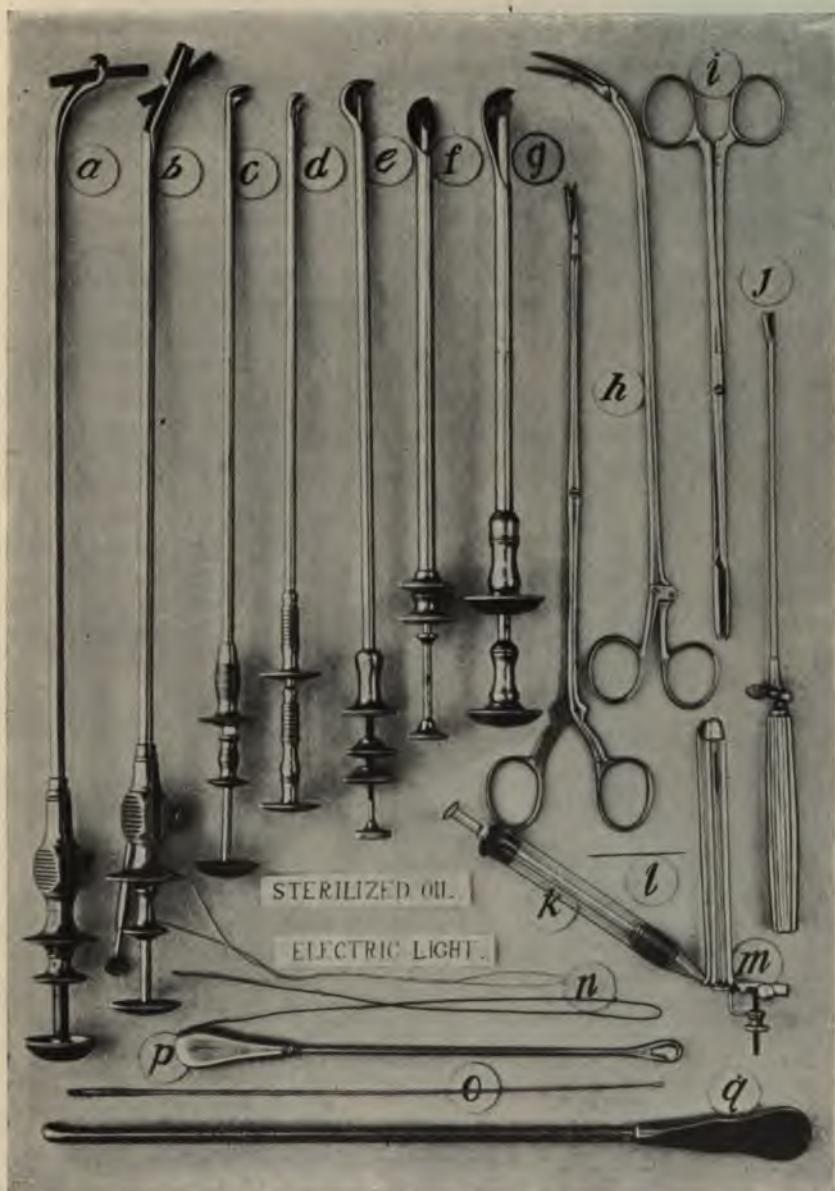
Fig. 1620.—Instruments employed in removal of foreign bodies from urethra and bladder.

a. Mercier's duplicator for use in the bladder. *b.* Collin's broken catheter extractor. *c.* Galante's crusher. *d.* Nélaton's urethral crusher. *e.* Reliquet's urethral crusher. *f.* Mathieu's lithotrite. *g.* Old pattern of urethral lithotrite with calculus in jaws. *h.* Mathieu's curved urethral forceps. *i.* Thompson's urethral forceps. *j.* Short-jawed urethral forceps. *k.* Syringe. *l.* Needle for "needling" stone in urethra. *m.* Urethral spatula. *n.* Loop of wire and of silkworm gut to lasso urethral calculi. *o.* Silver probe. *p.* Urethral scoop. *q.* Wheelhouse's staff for perineal section.

Infancy to Puberty.—Perineal lithotomy, 602 cases; suprapubic lithotomy, 637 cases; litholapaxy, 284 cases, with a death rate of 3.1, 13.1, and 1.7 per cent respectively.

Puberty to Middle Age.—Perineal lithotomy, 226 cases; suprapubic lithotomy, 159 cases; litholapaxy, 485 cases, with a death rate of 9.7, 11.3, and 4.5 per cent respectively.

Old Age. — Perineal lithotomy, 69 cases; suprapubic lithotomy, 91 cases; litholapaxy, 581 cases, with a respective death rate of 19, 18, and 7 per cent.

Cunningham, according to his own experience (133 cases), regards litholapaxy as suitable for all but 3 per cent of the cases.

Irrespective of the aforegoing results it should not be overlooked that one is likely to succeed best— other things being equal —in the use of the method of practice with which he is the most familiar.

Foreign Bodies in the Urethra.—It is rare indeed that stones form in the urethra. Usually they are arrested there during the passage of the urine. The prostatic sinus, the membranous urethra just behind the anterior layer of the triangular ligament (Fig. 1583, *d*), and the navicular fossa, are the common

Fig. 1621.—Suture of urethra after incision for removal of stone, etc. *a.* Forceps. *b.* Superficial perineal fascia. *c.* Accelerator urinæ muscle. *d.* Urethra. *e.* Sound or catheter for support of urethral walls during sewing. *f.* Depth to which stitches are carried. *g.* Sewed surface of urethra.

sites of lodgment. Sometimes they are arrested at the peno-scrotal junction. A marked narrowing at any part of the urethra may arrest their passage. Complete and incomplete obstruction may be caused, depending on the diameter of the stone or that of the canal. The degree of the obstruction is indicated practically by the arrest and the freedom of the flow of the urine through the urethra.

The Treatment.—In partial obstruction, the sudden arrest of the flow of urine and the distention of the urethra attendant on grasping the head of the penis during micturition may cause dislodgment and escape of stone. Distention of the canal in front by an oleaginous injection,
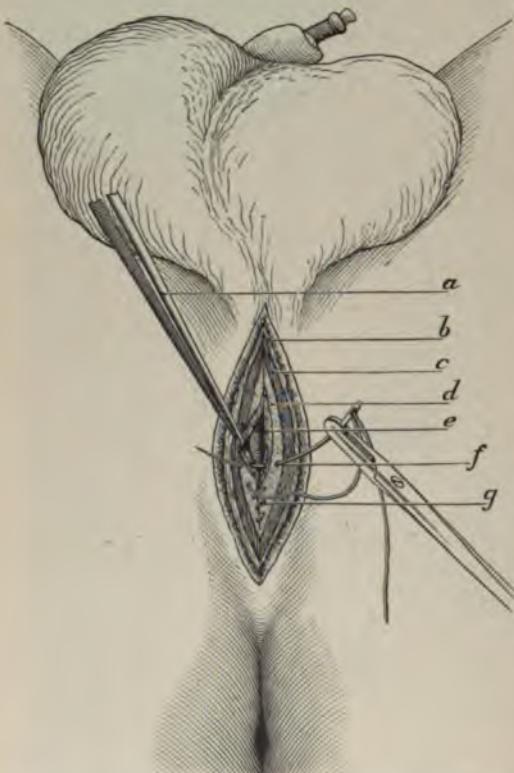
introduction and sudden removal of a large blunt sound during urinary effort, may meet the demand. If situated far in front, the stone may be worked out by manipulation with the fingers, aided by urinary pressure. If soft, it may be crushed with the fingers and washed out by the urine. If located behind the compressor urethræ, it may be pushed back into the bladder during a urinary effort and crushed later. A urethral scoop may be insinuated behind it while it is steadied with the fingers, or a small urethral stone crusher may be used in a similar manner, when the obstruction may be removed intact or crushed and removed (Fig. 1620). It may be caught and removed by means of the straight or curved alligator forceps (Fig. 1620). Failing in these expedients, it can be readily removed through a small free incision into the urethra at the site of lodg-

ment. It is better that the stone be removed through a free incision than to cause laceration of the urethra in the efforts of removal by other methods (Figs. 1621 and 1622). An incised wound of the urethra usually heals promptly. It may be feasible to needle it, as is sometimes practiced for gallstone obstruction (page 991). Sharp-pointed objects, like pins, needles, etc., can be removed as indicated in the illustrations (Figs. 1623, 1624, and 1625).

Foreign Bodies in the Bladder.—An unlimited variety of foreign bodies gain access to the bladder because of violence, defective instruments, the mishaps attending operative practice, and those incident to the acts of sexual perversion, etc. The nature, shape, and size of a foreign body, and the recentness of the entrance are all matters of special significance bearing on the question of promptness and method of treatment. The
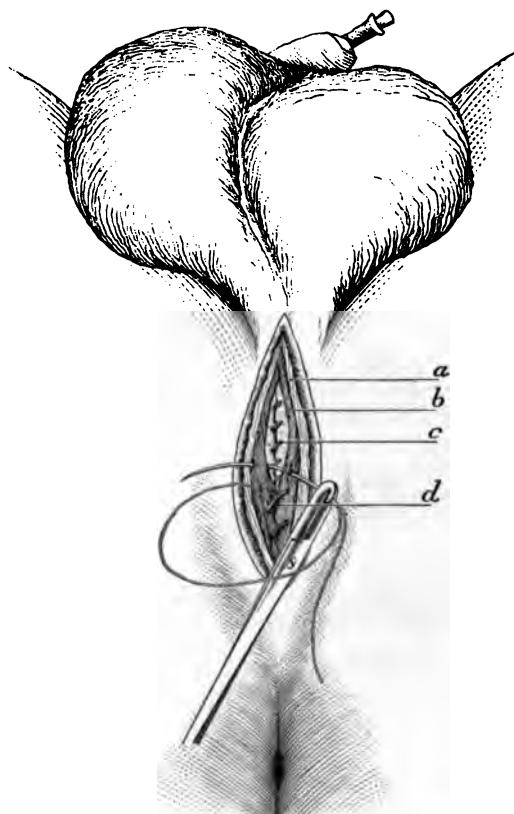
Fig. 1622.—Suture of deep tissue over line of urethral sewing. *a.* Superficial perineal fascia. *b.* Accelerator urinæ muscle. *c.* Line of sewing of urethra. *d.* Sewing muscular flaps over urethral incision.

th... and traverse the urethra should be taken away by routes. Small and freely movable objects may 'Fig. 1565 *et seq.*) or lithotrite. Long, flex-

ible, and suitably bent objects can be removed by instruments designed for the purpose (Fig. 1620). All objects are more easily and safely removed early in the history of the case, before incrustation or cystitis attend their presence. It is proper to note at this time that long objects usually lie transversely in the bladder, and when the organ is empty an object longer than four inches is thus placed, while one five or more takes a vertical or oblique position. The employment of the cystoscope, to determine the characteristics of the body, its location and direction should not be overlooked. If incrustation have already taken place, the gentle use of the lithotrite may be sufficient to dislodge it, especially if deposited on a flexible substance.

Catheters may be removed by withdrawal in the long axis (Fig. 1620), or by doubling, if the caliber of the urethra will permit. Much patience and skill are needed to locate and so change the direction of rigid bodies by means of instruments having, or devoid of, special mechanism as to secure their harmless delivery. The presence of cystitis or of kidney disease admonish that care be practiced in every manner.

Lithotomy, etc., in the Female.—Aside from lithotrity and litholapaxy, a stone may be removed from the female bladder by dilatation of the urethra, and by vaginal and suprapubic lithotomy.

FIG. 1623.—The removal of a pin from the urethra, first step. Causing pin to puncture tissues.

FIG. 1624.—The removal of a pin from the urethra, second step. Turning pin.

Dilatation of the Urethra.—Dilatation of the urethra is applicable to the removal of small stones. A stone an inch in diameter can be removed thus without much danger of troublesome incontinence of urine; when larger than this, another method should be practiced. The dilatation can be accomplished by large sounds, graded uterine stems, followed in turn by the fingers. Instruments specially designed for the purpose are often

employed. After suitable dilatation is secured, the stone is removed with slender forceps.

The Precautions.—Overdistention of the passage may cause rupture of the urethral structure and lead to incontinence. If the stone plus the thickness of the forceps be too large, the stone should be crushed and the fragments removed as in the male.

The vaginal method consists in connecting the vagina with the cavity of the bladder by a longitudinal incision made in the median line of the vagina, the length varying according to the size of the stone. The patient is placed in the knee-chest posture on the back and a grooved staff is introduced into the bladder; the position of the groove is ascertained by the finger, and the tissues between the finger and the groove are divided by a scalpel or scissors. The stone is grasped and removed by forceps; if too large, it should be crushed and removed piecemeal.

The wound in the bladder should be closed at once if practicable; if not, it may be left to heal spontaneously—

FIG. 1625.—The removal of a pin from the urethra, third step. Passing head out of meatus.

which it often promptly does—or can be closed thereafter by an independent operation. The tendency to the formation of phosphatic deposits during the healing process is controlled by frequent irrigation with tepid water only, or by tepid water acidulated with nitric or hydrochloric acid. A solution of the acetate of lead—one grain to the ounce of warm water—is highly extolled for this purpose.

Suprapubic Lithotomy in the Female.—If the stone be too large for removal by the vagina and too hard for crushing, the suprapubic method is then advisable. The technique of this method in the female is similar to that in the male (page 1416).

CHAPTER XVIII.

OPERATIONS ON THE SCROTUM AND PENIS.

Hydrocele of the Tunica Vaginalis Testis.—The operative measures for the treatment of this affection are the palliative and radical measures.

The Anatomical Points.—The testicle is variously situated in relation to hydrocele, usually behind (Fig. 1626), sometimes below (Fig. 1627 to 1630), and rarely indeed in front of it. The superficial tissues of the scrotum may cover loosely the fluid collection or be drawn smoothly around it, depending on the degree of the distention. The scrotal vessels can commonly be seen coursing through the tissues near to the surface. Not infrequently a hernial protrusion trespasses on the region. The position of the testicle and the presence of hernia ought always to be determined before the operation is begun. Transmitted light will indicate the relation of the fluid to the testicle and often determine the presence of intestine. However, the history of the case and the influence on the position of the intestine of dorsal decubitus are the better determinative means of the latter conditions.

FIG. 1626.—Usual form of hydrocele.

In a bilocular hydrocele (Fig. 1631) a constricted part of the vaginal process lying in the inguinal canal separates a hydrocele of the tunica vaginalis from a distended vaginal process above, shut off from the peritoneal cavity. From change in posture or alternating pressure above and below a variation in the sizes of the respective enlargements can be seen.

The Palliative Treatment.—The palliative treatment relates to the evacuation of the fluid from time to time, as recurring distention demands, by tapping. Comfort rather than cure is sought for, as this measure rarely indeed cures the affection, unless acute inflammation supervenes. Strict asepsis should be practiced in tapping, to obviate unbidden inflammatory sequels.

Tapping.—Tapping in a simple process, requiring a small trocar and cannula, or an aspirating needle, or an instrument of a similar nature. The patient is caused to sit upright on the edge of a chair with the limbs sepa-

1428

rated, or to lie on a lounge, and the enlargement is seized by the left hand and the tissues made tense over its anterior surface. The testicle is carefully located, and the course of the scrotal vessels as cautiously avoided. The instrument, guarded by the end of the finger to limit the extent of

FIG. 1627. — Hydrocele of the cord communicating with the tunica vaginalis testis.

FIG. 1628.—Hydrocele of the cord communicating with the peritoneal cavity.
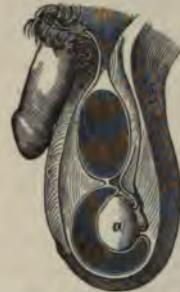
FIG. 1629. — Encysted hydrocele of the cord.
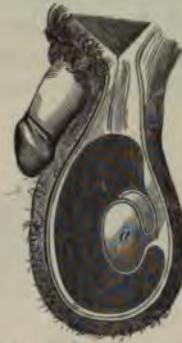
FIG. 1630.—Hydrocele of the tunica vaginalis testis.

the puncture (Fig. 1632), is quickly plunged upward and backward into the scrotum at about the junction of its middle and lower thirds. As the fluid escapes, the end of the cannula is turned away from the testicle, and the tumor is compressed carefully to expel the entire fluid collection. After the fluid is removed and the puncture is closed, the scrotum is suspended and the patient kept quiet, otherwise inflammation of the sac may occur, which, while it may lead to a radical cure, will not be welcome, as it causes much pain and confines the patient unexpectedly to bed.

The Precautions.—The testicle, the epididymis, or a herniated gut may be punctured by the trocar, unless the exact location of the fluid has been determined by transmitted light. A blunt trocar, or an ill-fitting cannula, or a halting thrust may push a thickened tunica vaginalis in front of the instrument. The puncture of a vein of scrotal tissue will cause extravasation and extensive ecchymosis of the s structure. An infecte cause extensive infla sloughing of the scr

The Results.-
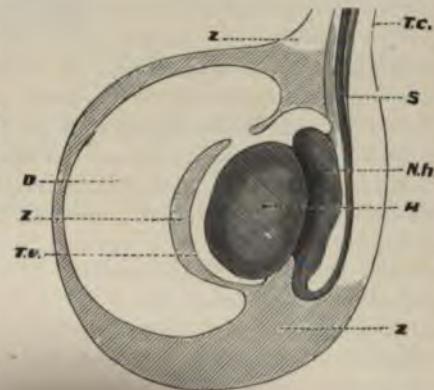
Bilocular hydrocele. *t.c.* Pari-tunica. *s.* Spermatic cord. *h.* Testis. *d.* Cavity Cavity of the tunica Inflammatory visceral and

the operation will probably be required in four or six months, and perhaps sooner. The redundant scrotum, due to overdistention, will soon approximate the normal dimensions.

The Radical Measures of Treatment.—The radical measures of treatment are injection, incision, and excision of more or less of the parietal layer of the sac.

The Treatment by Injection.—The treatment by injection usually begins after the evacuation of the sac by tapping. The fluids recommended for the purpose are quite numerous, among which the preparations of iodine and of carbolic acid (Levis)—especially the latter—are preferred. However, rectified spirit, port wine, solutions of the sulphate and chloride of zinc, and chloride of mercury, are each occasionally employed. The special apparatus required in the performance of the operation is the rubber injection bag, in addition to the ordinary trocar (Fig.

FIG. 1632.—The tapping of a hydrocele of tunica vaginalis, showing finger resting on instrument and tumor compressed by hand.

1633). After thorough aseptic preparation of the parts and with the patient sitting or lying, the trocar is introduced and the fluid drawn off as in tapping. The scrotum is then seized and held steadily, to prevent the escape of the extremity of the trocar from the cavity of the sac, and the medicated fluid is thrown in by means of the gum bag. If the compound tincture of iodine be used, it may be diluted with three or four parts of water. The introduction of three or four ounces of the mixture is quite sufficient. It should be brought in contact with the apposed surfaces of the sac by manipulation and retained for five or ten minutes, or until the patient complains of pain or faintness, and then allowed to escape through the cannula. If the pure tincture be used, a drachm or two injected in the same manner, and allowed to remain, is quite sufficient. If the sac be small, fifteen or twenty drops may be thrown into it by a hypodermic syringe, without the previous removal of the fluid, and its diffusion secured by manipulation.

A drachm or two of a ten- to fifty-per-cent solution of carbolic-acid crystals in glycerin may be injected and allowed to remain. From half a drachm to a drachm of pure carbolic is often injected into the empty sac, or while yet there remains a small amount of the fluid undrawn. Carbolic acid causes less pain and is a more constant and certain remedy than iodine. This plan of practice is strongly advocated by competent observers, and frequently after the injection the patient is permitted to be out and around. *Keyes* is a strong advocate of the use of carbolic acid fo

this purpose. After aspirating the "last drop" of fluid from the sac, he introduces into it from "10 to 100 minims of pure carbolic acid deliquized by heating," according to the size of the hydrocele. Brief and gentle manipulation of the testicle is then practiced to properly diffuse the fluid. On the following day the patient is allowed to be up and around if only moderate pain and swelling are present. Otherwise he remains in bed with the scrotum supported and palliative means employed. Undue tension is relieved by aspiration. We can speak with favor of this method of treatment. The attendant pain is much less severe than from many of the other agents, in fact, it may not be at all troublesome.

The Precautions.—Inasmuch as the pain attending the injection of some fluids is often severe, and as fainting may occur, the recumbent posture is advisable. The injection of a congenital hydrocele is manifestly a dangerous expedient, but the diagnosis of its presence will prevent accident. The unsuspected escape of the end of the cannula from the sac, and the consequent introduction of the injection into the scrotal tissues, is an unfortunate occurrence, especially when followed by extensive inflammation and sloughing. If the end of the cannula thus escapes, an independent puncture should be made at once, as the previous opening can not be easily found. Injection for the cure of a hydrocele dependent on malignant disease of the testicle is useless and misapplied treatment, to say the least.
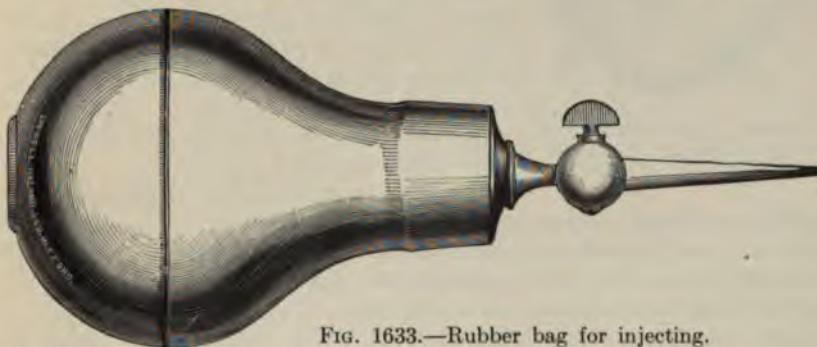
Fig. 1633.—Rubber bag for injecting.

Large hydroceles and those with thick walls are not suited for cure by injection.

The after-treatment in these cases consists in putting the patient to bed, suspending the scrotum and keeping evaporating lotions applied to it, and giving anodynes to allay pain. The patient should remain in bed until the acute symptoms subside, after which he is allowed to go around with the scrotum suspended. A month or so is requisite for the restoration of the parts to the normal state. Insignificant inflammatory reaction portends a failure of the attempt at cure.

The Results.—The use of iodine as commonly employed fails of cure in nearly 18 per cent of the cases. The percentage of failure from carbolic-acid treatment is less (13 per cent), and a second injection rarely fails to

cure. By this method of practice discomfort and confinement are reduced to a minimum. Rare instances of extension, local inflammation, of sloughing, of carbolic-acid poisoning, and of death, are reported as dependent on the carbolic-acid treatment.

The Open Treatment of Hydrocele.—The open treatment is indicated in the presence of hernia, organic disease of the parts, failure of cure by injection, and in cases of doubtful causation.

The Treatment by Incision (Volkmann).—After thoroughly shaving and cleansing the parts and wrapping the penis in gauze, the sac is laid open for two inches at the anterior and lower aspect of the tumor, and the bor-

Fig. 1634.—Treatment of hydrocele by incision, Volkmann's method.

ders of the tunica vaginalis are stitched to the edges of the skin incision by six or seven chromicized catgut ligatures introduced at either side (Fig. 1634). A large drainage tube is introduced into the cavity of the tunic, the wound dusted lightly with iodoform, and dressed with iodoform gauze. The patient is kept in bed for ten or twelve days, and the wound kept clean by repeated washing and dressing with an aseptic solution. The tube is shortened from day to day and removed entirely at the end of the first week. The catgut sutures are removed during the first week, and by the end of the third the patient is permitted to resume his usual mode of life with the scrotum suspended. The suspensory should be worn for three or four months after the operation.

The Remarks.—This operation permits of the examination of the testicle and determination if it be diseased. Sometimes an insignificant grade of inflammation of the testicle attends the healing of the wound. Insufficient drainage may be followed by extensive suppuration, and even sloughing of the tissues, especially in debilitated subjects. Light packing of the cavity with iodoform gauze may be used in place of the drainage tube. *Treves* practices a free swabbing out of the cavity of the tunica vaginalis with pure liquefied carbolic acid, followed by free drainage and frequent irrigation. *Longuet* employs a local anæsthetic, makes an incision two inches long into the sac, pulls the testicle out through the opening, allowing the serous and other coverings to fall together behind the organ, where they are held by a single catgut suture. The tissues at the inner edge of the wound are then separated with the finger, forming a bed into which the testicle is rotated so as to cause it to lie against the scrotal septum, the cord covered with the tunica. The integument is then sutured, the wound dressed, and the patient kept quiet until healing has taken place. This is a simple and successful operation.

The Treatment by Excision of Parietal Layer of Sac (Von Bergmann). —Either complete or partial excision of the sac may be practiced. In complete excision prepare the patient for this operation the same as for the

preceding methods. Make an incision three inches long at the anterior and outer aspect of the hydrocele into the sac; remove the parietal part of the sac from the structures of the cord and scrotum down to the testicle, if practicable, by blunt dissection, and cut it away with scissors. Introduce drainage, close the external wound around it with sutures, and dress the part snugly with gauze. The patient is confined to bed usually for a week or ten days.

The Treatment by Partial Excision.—In partial excision a portion of the sac is cut away for a short distance at either side of the primary incision. As a modification it allows a freer escape of the discharges, and prevents the protrusion of the rigid tunic, but otherwise it makes no practical difference with the outcome. The external incision in this method is made longer than in the former, affording, therefore, more suitable drainage.

The wound, after this operation, is treated in a similar manner as in the preceding method.

A still further modification of the technique presents, in our opinion, one of the best operative procedures for the radical cure of hydrocele. A long incision is made into the tunica vaginalis, and the condition of the testis ascertained. The rigid protruding borders of the divided tunic are then excised in the direction of the long axis of the external incision about halfway back to the testicle, and the borders of the remaining portions stitched by fine catgut to the subcutaneous scrotal tissues corresponding to them. The cavity is freely irrigated with a strong solution of bichloride of mercury or carbolic acid, a drainage tube is introduced, the scrotal wound closed around it, and the flaps quilted together back to the line of division of the tunica vaginalis by catgut sutures, to prevent the contractions of the dartos from disturbing the union and to limiting the area of the wound. The whole is then dusted with iodoform and surrounded by antiseptic gauze.

The wound usually heals completely under the primary dressing without an unfavorable manifestation.

The General Remarks.—Only a total obliteration of the sac affords a positive assurance of complete and final cure. A partial obliteration predisposes to a return. Permanent cures take place without any obliteration of the sac, as is illustrated by the rare instances of cure that follow simple tapping. The presence of limited hydrocele at any part of the sac or cord can be treated safely and successfully by the preceding means, provided vigilant diagnostic discrimination and proper surgical technique be exercised.

The Results.—Aseptic incision, with packing of the sac, or flushing or swabbing the cavity with an irritant, is productive of better results and with no more danger than is injection. The patients, however, recover more slowly and are confined longer in bed.

The Choice of Operation.—Radical cure by irritant injections should not be practiced in instances in which the hydrocele may be dependent on local or general disease, or be complicated with an illy defined or congenital hernia, or severe pain and extreme old age. The presence of multiple cysts, or a huge one, and repeat͏ed ͏ ͏ ͏ ͏ ͏ by this method or the fear of poisoning (carbolic) Therefore, treatment by palliative tapping ld be employed in these classes of

cases. If the hydrocele be congenital, an incision similar to that for the radical cure of hernia may be required for cure.

Castration (*Orchidectomy*).—Castration is ordinarily a simple operation, and practically devoid of danger to the patient except in special cases.

After the pubes, scrotum, and perinæum are shaved and thoroughly cleansed with soap and antiseptic solutions and the penis incased in gauze, place the patient on the back, introduce a large sponge below the testicles between the thighs to collect the fluids, and administer the anæsthetic.

The Operation.—Seize the testicle with the left hand and draw the scrotal tissues equally and tightly over it; make an incision from just below the external abdominal ring downward to the lower limit of the scrotum through the tissues down to the cord and tunica vaginalis, arresting hæmorrhage as it occurs. The testicle can now be removed along with the uncut tunic and with the cord by enucleation with the fingers or a dull instrument. In doubtful cases it is better to open the sac in order to scruti-
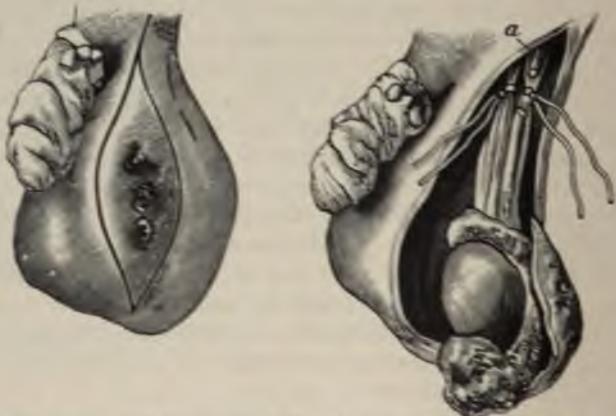
FIG. 1635.—The operation of castration with involvement of scrotal tissue. Penis wrapped in aseptic gauze. *a.* Ligatured vessels.

nize the testicle and judge if it be necessary after all that it be removed. Although an additional risk of infection is thus incurred, the possible gain to the patient and the readiness with which it may be enucleated, the same as before, wisely sanctions the step. If the testicle and the visceral layer of the tunic only are to be removed, the parietal part of the tunic is severed around the testicle as closely to it as possible with scissors. In the event of the removal of the organ, the cord is isolated with the finger to the upper limit of the incision (Fig. 1635), drawn down somewhat out of the ring, clamped only sufficiently tight to control hæmorrhage, and cut off about half an inch below the point of seizure. The three arteries of the cord (Fig. 1662) are each tied independently with catgut. The veins also should be tied. The outer surface of the cord is then seized at either side with forci-pressure to prevent its undue retraction and to provide
drawal from the ring if hæmorrhage happen after re
Remove the clamp, examine the stump for bleeding, an

remove the forcipressure and permit the cord to retract. The borders of the wound are now brought together accurately and stitched with catgut or silkworm gut, leaving room below for the introduction of drainage if needed. If the need of removal of the sac and testicle be self-evident, it can be readily accomplished without exploration by exposing above the cord through a free incision and separating the tissues downward along the cord, pushing the tunic and the testicle upward through the incision. This course limits the extent of the cutaneous wound and correspondingly lessens the extent of the sewing, dangers of infection, etc. If the bottom of the scrotum be buttonholed, ample opportunity for the establishment of drainage requirements is afforded. The cord is treated the same as in the preceding instance and the incision closed by sewing.

The Remarks.—If the scrotal integument be involved, an eliminating elliptical incision should be made (Fig. 1635). Redundant integument should be removed if much relaxed or of exceeding amount. If the disease be non-infective, the incision may be made as brief as possible. If a hernia be present, a radical cure can be performed at the same time if not contraindicated. In fact, the incision is varied to meet the requirements of the case.

The Precautions.—Care should be exercised to detect the presence of a hernia at the seat of operation, for apparent reasons. In malignant disease the lymph nodes directly associated with it should be removed, whether enlarged or not. Cauterization of the end of the vas deferens should be practiced if it be infected by disease extension. The incautious division of an overstretched cord will cause the stump to disappear promptly out of reach. Therefore, division of the cord during manual or tumor-weight traction should be carefully avoided. Neuralgia and secondary hæmorrhage may follow the tying of the cord *en masse*; the former may arise from transfixion of the cord. High division of the cord should be practiced in the instance of malignant disease. In non-infective cases it may be tied within an inch or so of the testicle, if feasible. Retention of urine sometimes follows castration, and the liability of its occurrence should always be anticipated and provided for. Care should be exercised in uniting the borders of the wound, or the movements of the dartos will disarrange the coaptation. The writer practices the introduction through the borders of three or four deep sutures for the purpose of better controlling these movements, after which the more superficial sutures are applied and proper adjustment of the cut borders secured. Strong lotions should not be used in washing the scrotum, as they often cause acute suffering and severe irritation. For cosmetic purposes, a celluloid body of the size and shape of the remaining testicle may be introduced into the scrotum, and be borne with comfort and satisfaction.

After-treatment.—The wound is drained, dressed, and attended thereafter in the manner characteristic of aseptic treatment. When employed, drainage is removed at the first dressing; the sutures at the end of the first Strapping may be needed to complete the deep healing satisfactorily. ults.—The danger to life when done for malignant disease is About 12 per cent remain free from return for more than

three years.   Castration is employed for chronic prostatic enlargement (page 1352).

Orchidopexy.—Orchidopexy relates to the bringing down into the scrotum and retaining there of an incompletely descended testicle. This plan is not attempted until after failure of simpler means and the lapse of time render operative steps advisable. The external ring is exposed through a free incision, which is extended upward or downward, as circumstances require, to reach the testicle. The testicle is seized and drawn downward, while the cremaster muscle and other unimportant restraining tissues are divided by careful dissection. The scrotal structures are then separated by blunt dissection so as to form a suitable nidus for the deposit of the organ, after which it is retained in position by wrapping around the cord between the external ring and the testicle the contiguous scrotal folds and securing them in place by sutures. The successful attainment of these steps is not as easy nor finally as satisfactory as might appear from the description. Instrumental restraint is advised after the operation to retain the organ in place while awaiting the gain arising from increasing growth. The unsatisfactory outcome that has so often followed these efforts of restoration has prompted the selection by some operators of other means of treatment. Dawbarn advises the raising and planting of the testicle so deeply beneath the tissues at the internal aspect of the inguinal canal that it will be removed from harm and also escape the dangers attendant on scrotal implantation.

Dowd, with the view of gaining as much as possible in length of the cord, shortened its course by division of " the transversalis fascia from the internal ring downward to the pubic bone." This course obviated the restraining influence of the vas deferens. The remaining restraint was quite overcome by careful division of the cremaster muscle, supplemented with gentle traction on the cord and testicle. By these means the organ could be secured below the pubic bone by stitching to the scrotum. The incision in the fascia was sutured, and after healing a truss was worn for three months to prevent retraction. At the end of a year the parts were in their normal relation.

Bevan's Operation.—This excellent operation is performed as follows: Make an incision through the integument, fascia, and aponeurosis of the external oblique three inches in length to the external abdominal ring; draw aside the borders of the wound, exposing to view the cremasteric fascia (Fig. 1636) ; divide the cremasteric and transversalis fasciæ (infundibuliform) (Fig. 1637) parallel with the canal, exposing the peritoneal sac associated with the testicle and continuous with the peritoneal cavity; open the sac, exposing the testicle to view, also perhaps a little omentum (Fig. 1638) ; cut transversely across the peritonæum (vaginal process), as indicated in Fig. 1637, and carefully separate it from the underlying cord; ligature the peritoneal process (vaginal) well up to the abdominal ring, as in hernia operation (Fig. 1637) ; close with a purse-string suture the peritonæum in contact with the testicle, thus forming a tunica vaginalis for that organ; lift the testicle out of its bed and pull gently on the cord so as to let it as much as possible and causing the shortened bands of as

nective tissue to become tense; tear across the tense bands with forceps and strip from the cord the surrounding fascia, leaving only the vessels and vas deferens; separate the vessels and the vas from the peritonæum with the fingers carried along the course of each into the pelvic cavity (Fig.
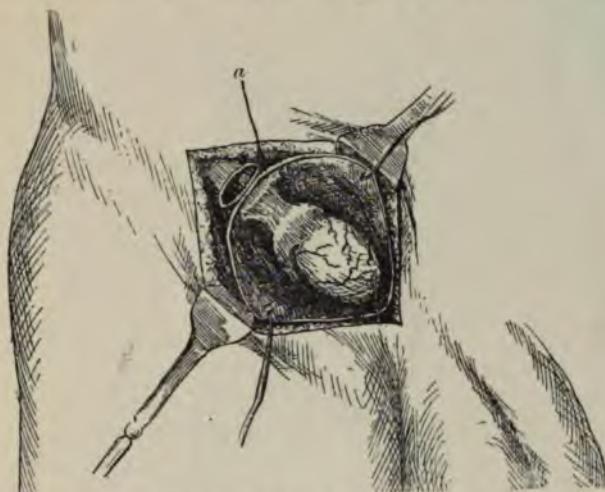
FIG. 1636.—Operation for orchidopexy, Bevan's method. Sac opened, testicle exposed.
a. Vaginal process divided.

1638), thereby lengthening the cord so that the testicle can be placed three or four inches below Poupart's ligament; make, by means of blunt dissection with the fingers, a pocket in the scrotum for receiving the testicle (Fig. 1639); drop into this pocket the testicle and confine it in place without
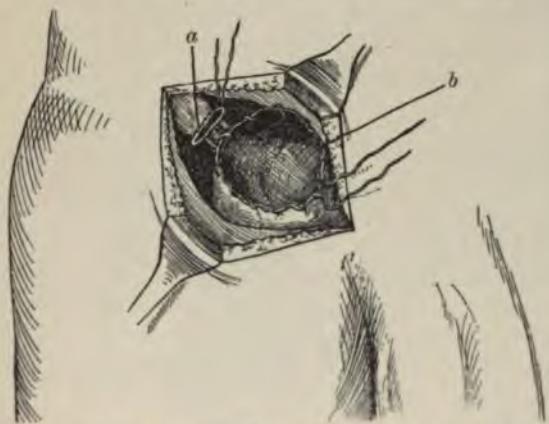
FIG. 1637.—Operation for orchidopexy, Bevan's method. *a*. Ligature of vaginal process (peritoneal). *b*. Purse-string suture of serous membrane to form tunic for testicle.

of a purse-string suture passed around the neck of the
lude the superficial fascia and both pillars of the exter-

nal ring above the cord; bring together with sutures the conjoined tendon and Poupart's ligament, leaving the cord in the canal; close the superficial
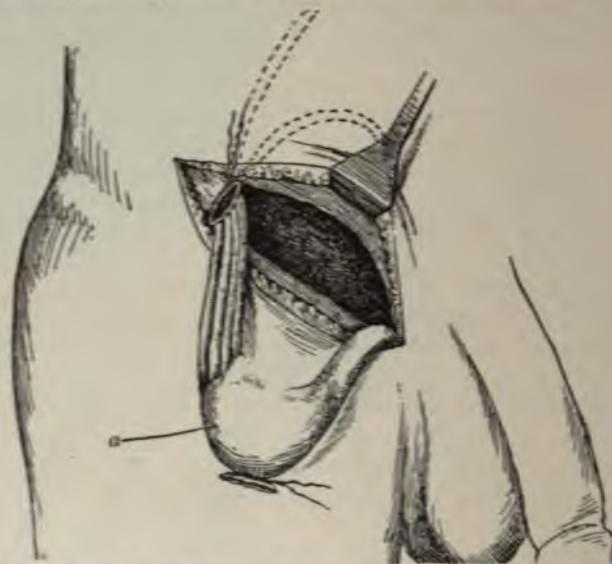
FIG. 1638.—Operation of orchidopexy, Bevan's method. Cord lengthened, vessels and vas separated from peritonæum and shown (dotted lines) going in respective directions. *a.* Testicle freed and ready for replacement.

wound as in hernia, and keep the patient quiet until repair is effected.

The Comments.—The differences in direction taken by the spermatic
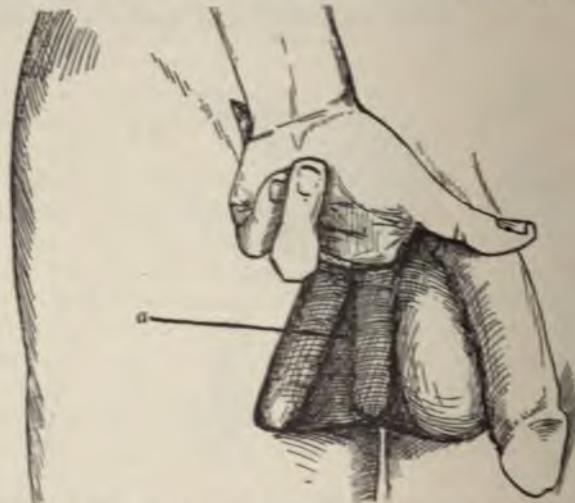
FIG. 1639.—Operation of orchidopexy, Bevan's method. *a.* Making pocket for testicle. Blunt dissection with fingers.

vessels and the vas deferens and its artery should be noted as bearing on the ability of the operator to effect the desired end. It appears that the vas

and its artery do not hinder proper deposit of the testicle; also that the spermatic vessels sometimes do, and then, if divided, the testicle may be properly nourished by the former vessel the same as in radical cure of hernia.

The Remarks.—In the division of the restraining tissues of the cord, injury to the vessels and nerves and the vas deferens should be carefully avoided. In the instances in which the undescended testicle is functionally useless, and only sentiment urges orchidopexy, the removal of the misplaced organ and the introduction of a false one into the scrotum may satisfy the
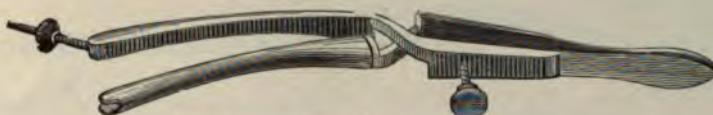
FIG. 1640.—Henry's phimosis forceps.

FIG. 1641.—Fisher's phimosis forceps.

sensibility of the patient, and relieve him, at the same time, of the annoyances and dangers from the imprisoned organ.

Circumcision. — Circumcision is practiced when phimosis or an uncomplicated redundancy of the foreskin exists, to relieve the patient's pain and annoyance from these conditions. The patient is placed on the back, and general or local anæsthesia administered. The object of the operation is not to remove the foreskin so as to leave the entire glans penis exposed after recovery, but to allow sufficient integument to remain to afford the protection characteristic of the normal prepuce. The situation of the base and apex of the glans should be determined, and with a pen or pencil an oblique line is drawn corresponding to the direction of the base of the glans, about midway between it and the apex, upon the integument. The foreskin is then drawn downward, placed

FIG. 1642.—Clamping the foreskin. Glans penis followed by dotted line.

between the blades of the clamp (Figs. 1640 and 1641), with the line just made corresponding to the lower border of the blades, care being taken not to include the glans in the grasp (Fig. 1642). The clamp is tightened, and the distal portion severed by a scalpel or scissors (Fig.

1643). The clamp is then removed (Fig. 1644), when the integument retracts to or a little behind its previous location (*a*). The mucous membrane, which still covers the glans, is slit up on a grooved director, along the dorsum to the corona (*b*), and trimmed symmetrically on side, not even with the integument (*c*), but near enough to it so that when it is turned over and its free borders are stitched to the skin, a vermilion
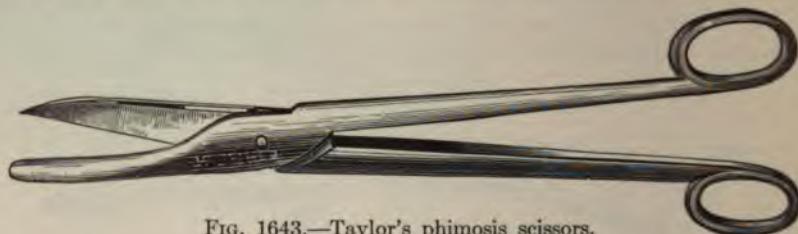
FIG. 1643.—Taylor's phimosis scissors.

border (*d*), at least a third of an inch wide, is formed. Before the sewing is done, the mucous membrane should be stripped off the glans to a point behind the corona, all smegma removed, and the part cleansed, after which the mucous sleeve is returned to place, and its border joined to that of the integument by an interrupted or continuous fine catgut suture. If the mucous membrane grasp the glans too tightly, thus predisposing to the occurrence of paraphimosis, it must be slit on the dorsal surface up to its point of reflection, after which the borders are joined as before described. The final division of the membrane at the dorsum will permit the prepuce to accommodate itself to the varying dimensions of the penis that occur not infrequently during the process of healing.

Keyes's Method.—Keyes's method is an admirable one (Fig. 1645), and is intended to meet the same reparative indications as the preceding. In this the mucous membrane is not slit up, but both it and the integument are shaped to correspond to the outlines *a*, *b*, *c*, and *d*, *e*, *f*, respectively,
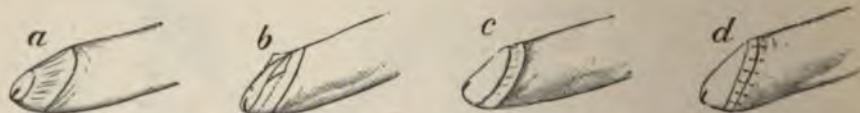
FIG. 1644.—The steps of circumcision. *a*. The retraction of integument. *b*. Slitting of mucous membrane on dorsum. *c*. Turning back mucous cuff. *d*. Stitching mucous cuff to integument.

after which the former flap is reflected backward and joined to the integument, so that *b* shall correspond to *e*, *a* to *d*, and *c* to *f*. This plan does not, however, insure the same freedom from constriction as does the long dorsal slit just described. If the phimosis be not attended by an elongation of the foreskin, a cure may be effected by slitting up the dorsal surface on a director to the base of the glans (Fig. 1646). The earlike projections on either side are then trimmed off (Fig. 1647), and the mucous and cutaneous borders stitched to each other with catgut. *Roser's* triangular-flap method

is easily performed and of serviceable outcome. A dorsal division of the prepuce is made with scissors or a director and pointed scalpel. After the division the outer layer of the prepuce retracts more than the inner (Fig. 1648). The inner layer is then divided at either side obliquely outward to the border of the glans, and the small triangular flap thus formed above is turned over into the angle formed by division of the outer layer and sutured in place. After suitable trimming of the earlike angles of the outer

FIG. 1645.—Keyes's modification.

FIG. 1646.—Dorsal slit.

FIG. 1647.—Trimming foreskin.

layer, the corresponding borders of the two layers are sutured together. *Cullerrier*, after thorough cleansing of the subpreputial space, accomplished well the purpose in this condition by subcutaneously dividing the mucous membrane in three or four places by means of blunt-pointed scissors, the blunt point resting upon the glans, while the sharp one was passed between the membrane and the integument. If the prepuce be short, and the case not an aggravated one, the *mucous lining may be stretched*, and even torn asunder, by introducing the blades of dressing forceps between the glans and foreskin and expanding them, after which the foreskin is drawn backward and retained until healing is completed.

The Precautions.—If too much tissue be left at the frenum, a disfigurement follows of annoying duration. If forcible traction be made on the foreskin before its severance, the integumentary portion will be made much too short. If the foreskin be adherent to the glans, and the preputial orifice be small, the grooved director may be carried into the urethra and the glans divided. If commendable cleanliness be not exercised in this operation and maintained in the treatment, troublesome cellulitis may follow. The doctrinal method of practice is sometimes followed by this complication.

FIG. 1648.—Roser's operation for phimosis. *a.* Inner layer of the prepuce. *b.* Cut edge of the outer layer. *c.* Triangular flap formed from the inner layer by two oblique incisions.

The Remarks.—Fine catgut, continuous or interrupted sutures, should be employed in sewing, and the stit   ' be placed as near to the borders as possible, so that they wil   ithout pain or disfigure-

ment, thus forestalling the annoyance of removal. Horsehair is sometimes used in sewing the borders together. Only trifling hæmorrhage occurs in adults; in infants scarcely any. Sometimes in infants the tissues are permitted to heal without suturing; and often, too, in infants the dorsal slit completes the operation.

The After-treatment.—The after-treatment in all the methods of operation is directed to modifying the inflammation, preventing the occurrence of erection of the penis, and keeping the parts clean.

The wound is dressed at first by surrounding it with a narrow piece of dry aseptic iodoformized gauze drawn closely in place and carried upward so as to cover the entire organ. After a day or so this dressing can be soaked off by placing the patient in a warm tub bath or by gentle irrigation with warm sterilized water, followed by the same treatment as often as cleanliness and comfort require. The penis should be supported by a textile fabric ring within which it rests, and the clothes should not be permitted to come in contact with the sensitive glans. A capacious cradle interposed for this purpose meets the indication and at the same time affords good ventilation. All constriction of the organ should be prevented, to obviate the œdema of the parts which will surely follow. In the adult a cold-water rubber coil carried around the penis may prevent erection and the pain and tearing of the tissues incident to this happening. The application of oleaginous substances should be limited to the glans and borders of the dressing exposed to wetting with urine. The application of collodion to the borders of the wound is objectionable on account of the contraction attending fixation. If stitch irritation does not take place, the stitches may remain until released by absorption. Troublesome erections may be palliated, if not prevented, by the use of cold, dry applications.

Fig. 1649.
Paraphimosis.

Fig. 1650.—Results of
the constriction.

In one case we now recall, local and general medication combined were not sufficient to control or hardly mitigate the tendency to erections; however, the complication was effectually met by employing a nurse to watch the organ while the patient slept, with instructions to awaken him on the appearance of the first indication of an erection.

The Results.—The danger to life or to the integrity of the organ is scarcely entitled to the dignity of mention if aseptic measures be practiced throughout. If healing by granulation takes place, or the operative technique be faulty, the preputial opening may become too small and be rigid and unyielding.

Paraphimosis (Fig. 1649).—In paraphimosis the foreskin i lodged behind the corona glandis, so as to cause great congestion

and sloughing of the parts if not relieved (Fig. 1650), and the condition may even terminate in gangrene and sloughing. *The reduction* of the foreskin may be accomplished in the following manner:

Oil the parts well, and administer an anæsthetic if necessary; grasp the penis behind the constriction with the thumb and fingers of the left hand, and the glans with the tips of the thumb and fingers of the right; press the glans with the latter gradually to reduce the swelling, then draw the constriction

Fig. 1651.—Paraphimosis. First method of reduction.
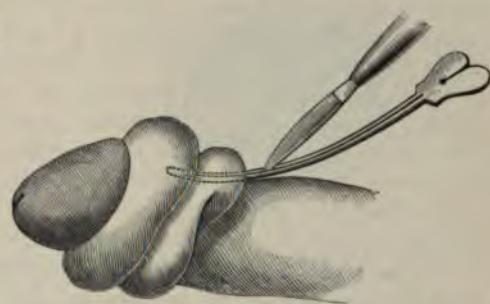
Fig. 1652.—Slitting up the constriction on a grooved director.

forward with the left, while the glans is gradually forced through it with the thumb and fingers of the right (Fig. 1651). If the constriction be not great, and the œdema and congestion be moderate, this manipulation

Fig. 1653.—Paraphimosis. Second method of reduction.

Fig. 1654.—Paraphimosis. Third method of reduction.

e reduction. In all cases where much œdema exists, acu-
performed, and the fluids squeezed through the open-

ings before reduction is attempted. When the part is corrugated and much swollen by long-standing severe constrictions, followed by inflammation and plastic œdema, and perhaps by incipient gangrene, it will be necessary to sever the constriction freely on the dorsal surface by a sharp-pointed, curved bistoury (Fig. 1652). Other methods of grasping the penis are recommended to effect the reduction of the foreskin (Figs. 1653 and 1654).

The Comments.—The employment of specially devised instruments to compress the distended glans is a refinement of needless birth. The elimi-
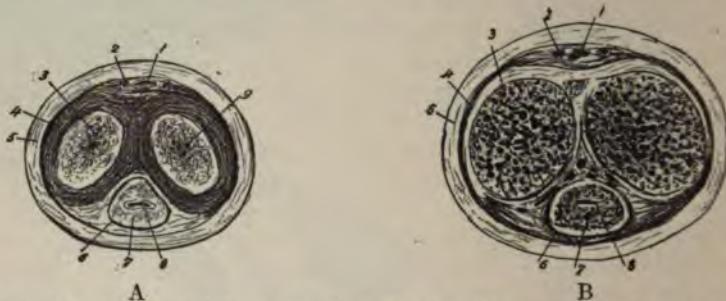
FIG. 1655.—Cross section of the penis. A, in flaccid, B, in erect condition. *1, 2.* Dorsal vein and artery. *3.* Corpora cavernosa. *4.* Tunica albuginea. *5.* Integument. *6.* Tunica albuginea of corpus spongiosum. *7.* Erectile tissue. *8.* Urethra.

nation of œdema by acupuncture followed by elevation of the organ and by hot, soothing applications, will very often prepare the way to prompt reduction. However, if impending sloughing be noticeable, free and prompt division of the constriction, followed by the palliative measures, will secure the promptest and most satisfactory results.

After-treatment.—Following reduction, thoroughly cleanse and disinfect the parts; place the patient in bed, with the penis elevated and supported, and dress with soothing antiseptic lotions.

Amputation of the Penis.—Amputation of the penis is commonly practiced for the purpose of removal of malignant disease.

The Anatomical Points.—The organ is abundantly supplied with blood-vessels and lymphatics, and well suited, therefore, to malignant spread from the anatomical standpoint. The arrangement and relations to each other of the important vessels and structures is better shown by the illustration (Fig. 1655) than words can depict.

Prepare the sound portion of the penis, the pubes, and scrotum for operation by aseptic measures; cleanse and surround the diseased portion with antiseptic gauze; empty the bladder, place the patient on the back and administer an anæsthetic.

The Operation.—Introduce a sound into the urethra and give it in charge of an assistant; pass the rubber band firmly twice around the base of the penis and clamp or tie the ends, to control the circulation (Fig. 1658); hold the penis lightly and conveniently with the hand; divide the integument with a circular cut around the penis with a scalpel; divide the corpora cavernosa vertically down to the corpus spongiosum; isolate the corpus spongiosum forward for an inch; remove the sound and cut off the spongy

body at the anterior limit of exposure; tie the open mouths of the vessels and remove the rubber constriction; arrest further bleeding and slit up the urethra for three fourths of an inch at the lower surface and turn up the resulting flap; snip off the angles at the upper border and join the margins of the urethral flap to the integumentary with fine interrupted catgut sutures, being especially careful to get good juxtaposition below to prevent urinary infiltration; draw the integument backward so as to bring the flaps in firm contact with the divided ends of the corpora cavernosa, putting a catgut suture deeply through at either side to hold them in place; introduce a soft-rubber catheter into the bladder, clamp the end and fasten it there; surround the stump of the penis with aseptic gauze held firmly in place with the catheter protruding through it, and fastened in position; support the scrotum and the dressing with an apron or T-bandage; attach to the catheter a small rubber tube, causing it to pass beneath the surface of an antiseptic fluid contained in a vessel placed (Fig. 1494) beneath the bed. The dressing is changed when soiled and a fresh dressing applied. The cases thus far treated in this manner by the writer have healed promptly by first intention, and the dressing has been dispensed with in a week's time. *Treves* advises that the urethra be slit along the dorsum, turned down, and the lower end stitched to the integument below, which is made longer for this purpose. The sides of the flap are sutured to the corpora cavernosa. The mode of dressing is substantially the same, and in both instances the skin turns inward and forms a puckered prepuce at the end of the stump.

The Flap Method of Amputation.—An excellent stump and rapid healing follow this method. After the proper control of the vessels, extend the penis gently and enter a narrow-bladed knife at a point well removed from
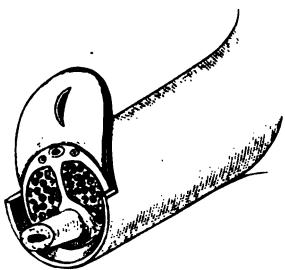
FIG. 1656.—Amputation of penis. Long superior oval-shaped flap. Short inferior flap.
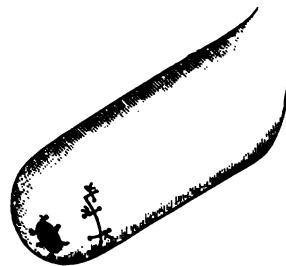
FIG. 1657.—Amputation of penis. Flaps united and urethral opening fixed.

the disease, between the corpus spongiosum and the corpora cavernosa, and cut forward and downward through the tissues, making a flap about three fourths of an inch in length, from which the urethra is then dissected. Make a long oval-shaped flap from the dorsum and sides of the penis of much greater length than that of the first; reflect the flap back and divide the corpora cavernosa vertically downward to the point of transfixion (Fig. 1656); remove the rubber constriction; secure the ʼ ꞌ points; puncture the upper flap at the middle; carry the uret   ꞌhe opening

and sew its extremity to the edge of the slit and the borders of the flaps to each other with catgut (Fig. 1657). Introduce the catheter and dress and treat as in the preceding method.

Hilton modified the operation by dividing the spongy body about a fourth of an inch in front of the cavernous portion, splitting it longitudinally, and uniting the lateral flaps thus formed to the integument.

Humphrey turns back from the integument of the penis a circular flap about half an inch in length, divides the corpora cavernosa on a level with the attachment of the flap, and cuts the spongy body at least half an inch longer than the cavernous bodies, and attaches the integument to its extremity.

An old method of practice, now rarely employed, consists in transverse division of the organ (Fig. 1658, *a*), followed by suture of the borders of the divided end of the urethra (*b*) to those of the severed integument (*c*). A catheter is introduced into the urethra, and the raw surfaces are carefully apposed to each other by means of suitable dressings.

Thiersch amputated the penis at the pubes, split the scrotum, divided longitudinally the corpus spongiosum the distance of an inch, and brought the free end of the urethra out of a wound made in the perinæum an inch
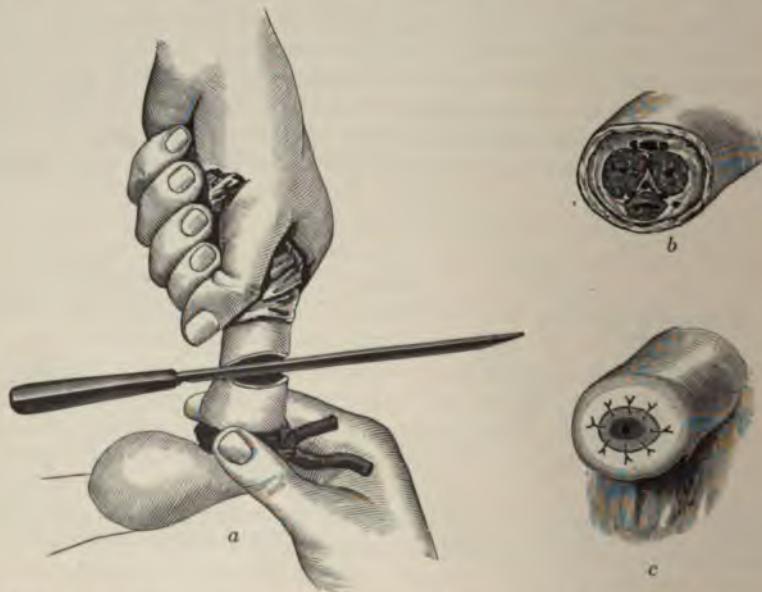
FIG. 1658.—Amputation of penis by transverse division. *a*. Act of amputating organ constricted with rubber tube. *b*. End of stump, showing vessels, urethra, and cavernous bodies. *c*. Integument united to urethra.

and a half in front of the anus, to the borders of which the extremity of the urethra was stitched.

Davis-Colly amputated the penis at the scrotum; then, through an incision made into the posterior scrotal rhaphe down upon the urethra, he iso-

lated the corpus spongiosum, brought the divided extremity out through the opening, and stitched its borders to those of the incision.

The Precautions.—If the amputation is to be made close to the symphysis, retraction of the stump and infiltration of the scrotum with urine must be guarded against. If a stout ligature be passed through the fibrous sheath of the penis, a little above the point of proposed section, the stump can be controlled and the first accident, and possibly the second, will be obviated by this means. At all events, the infiltration can be prevented by dividing partly or entirely through the scrotum and the floor of the urethra, in the line of the urinary canal, and uniting the borders of the integument to those of the urethra so as to form two scrotums (Fig. 1659), with the urinary opening between them. A disarrangement of the drainage or withdrawal of the catheter by traction on the tube often leads to prompt saturation of the dressings. If the patient be intractable in this respect, the catheter is employed every four or five hours, and it may be withdrawn entirely or only partially after each introduction, as may be deemed es-

Fig. 1659.—Amputation of penis close to scrotum. The latter split and divided borders sewed together, inclosing testicles.

sential. If complete withdrawal be practiced, a long silkworm-gut suture should be stitched at the outset to the floor of the urethra as a guide to the opening. Infiltration of urine between the flaps should be studiously avoided. If the line of junction be smeared with iodoformized vaseline with each dressing, the liability to this complication is considerably lessened. The lymphatic nodes in the line of the lymph flow of the penis, whether enlarged or not, should be sought for and removed at once in malignant disease. In every case careful stated periodical surveillance should be exercised after operation, in order to detect and eliminate the earliest manifestations of lymphatic involvement or disease recurrence. It is wise, too, to subject the lymph nodes to microscopical examination, to determine in them the presence of malignant processes.

The Remarks.—The scrotum and the wound should be kept clean, and the former frequently anointed with vaseline to prevent irritation. If repair by granulation takes place, a structural narrowing of the opening may follow. Transfixion sidewise of the corpora cavernosa with a long needle, and application of the constricting agent behind it, is advisable if a short stump is to be formed, as then the latter is better controlled and prevented from retracting into the soft parts. Do not amputate within three fourths of an inch of the disease, if avoidable.

Extirpation of the Penis.—Extirpation of the penis is practiced only when the disease is extensive and no complications are present that forbid the operative technique.

The Operation (Gould).—Cleanse the parts thoroughly; place the patient in the lithotomy position; incise through the scrotum in the median
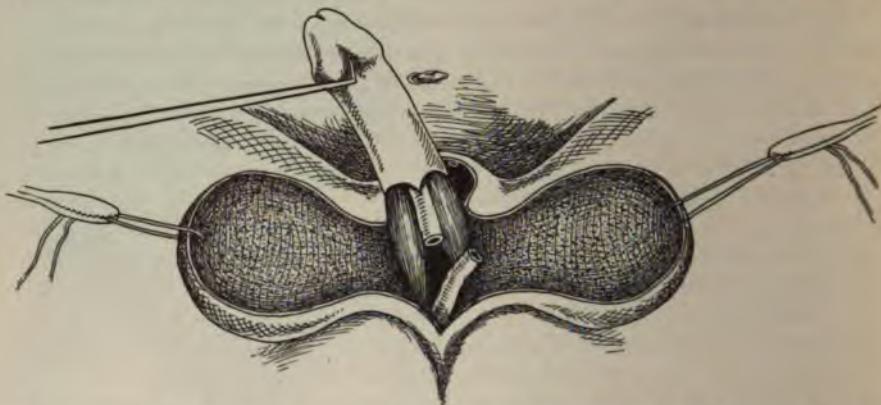
FIG. 1660.—Operation of extirpation of the penis. Gould's method. Scrotum divided in median line; urethra severed beneath arch of pubis. Crura exposed for removal with knife or periosteotome.

line the entire length of the rhaphe; separate the scrotum into halves (Fig. 1659) down to the corpus spongiosum with the finger and handle of the scalpel; introduce into the urethra, down to the triangular ligament, a full-sized sound or catheter; insert a long, thin-bladed knife transversely between the isolated corpus spongiosum and the corpora cavernosa; withdraw the instrument from the urethra; sever the urethra (Fig. 1660) at the pubes and detach it backward to the triangular ligament; make an incision around the root of the penis continuous with the one in the median line; divide the suspensory ligament and separate the penis, except at the attachment of the crura, with a scalpel, disconnect each crus from the pubic arch with a periosteal elevator; ligature the bleeding vessels; slit up the corpus spongiosum for about half an inch; raise the edges of the divided urethra and stitch them to the back part of the scrotal incision (Fig. 1661); close the remainder of the scrotal incision with sutures, and establish through-and-through drainage if required in the deep part of the wound. A catheter is not used. The wound is cleansed and dressed in the usual manner.
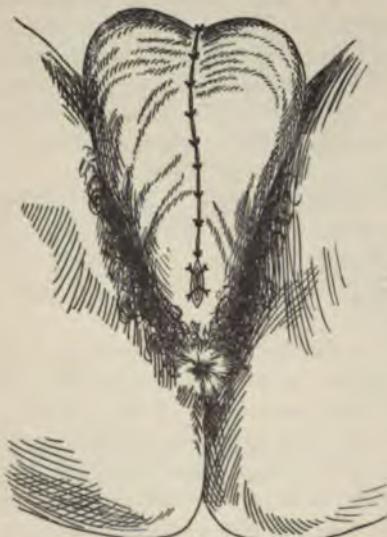
FIG. 1661.—Operation of extirpation of penis; open end of proximal part of urethra joined with the suture line uniting the halves of the scrotum above and below.

The Remarks.—Extensive glandular involvement and enfeebled reparative power contraindicate the operation.

Gouley's Method.—In Gouley's method make a curvilinear incision at either side of the root of the penis, beginning in the median line, about an inch and a half above the level of the pubes and ending a little below the peno-scrotal junction. The cavernous bodies are exposed and transfixed
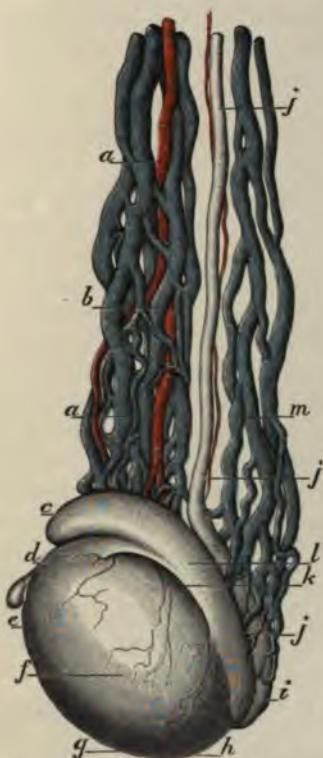
Fig. 1662.—The vessels of left testis and cord (outer surface). *a, a.* Spermatic artery. *b.* Anterior spermatic veins surrounding artery. *c, l, i.* Head, body, and tail of epididymis. *d.* Anterior extremity of (with hydatid of Morgagni), *e, g,* antero-inferior surface of, *f,* outer surface of, *k,* postero-superior surface of, and *h,* postero-inferior extremity of testicle. *j, j, j.* Vas deferens and its artery. *m.* Posterior spermatic veins.
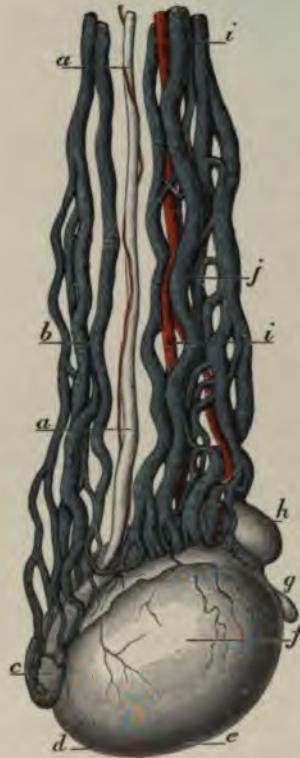
Fig. 1663.—The vessels of left testis and cord (inner surface). *a, a.* Vas deferens and its artery. *b.* Posterior spermatic veins. *c, h.* Tail and head of epididymis. *g.* Anterior extremity of testis and hydatid of Morgagni. *f.* Inner, *e,* antero-inferior, *d,* postero-inferior surfaces of testis. *i, i.* Spermatic artery. *j.* Anterior spermatic veins surrounding artery.

with a large knitting needle or with a suitable substitute; the urethra is transfixed by a smaller instrument of like nature on the same plane, and the penis is amputated an eighth of an inch in front of them. After all the bleeding points are secured, a grooved staff is introduced through the urethra into the bladder. A sharp-pointed scalpel is then carried through the peri

næum and lodged in the grooved staff, and all the tissues, including the scrotum, are divided from behind forward. The urethral cut is about an inch and a half in length, and the cutaneous one three inches. The urethra is now detached from the cavernous bodies, which, together with their crura, are dissected away, after which the borders of the urethra are united to those of the perineal wound. The testicles are inclosed separately in the scrotal tissues at either side of the perineal incision, by sewing together their divided borders (Fig. 1659).
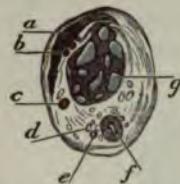
FIG. 1664.—Transverse section of cord at left abdominal ring. *a.* Cremaster muscle. *b.* Cremasteric vessels. *c.* Spermatic artery. *d, e.* Vessels of the vas deferens. *f.* Vas deferens. *g.* Pampiniform plexus, i. e., spermatic veins.

The Results.—*Butlin* reports 53 cases of simple amputation with one death. In extirpation the rate is about 6 per cent. Of 65 cases 23 had passed successfully the three-year limit. Urination is quite well done and intercourse may be fruitful except in cases of extirpation.

Varicocele.—Varicocele is a term applied to a varicose state of the veins of the spermatic cord. The veins here, as in other parts of the body, may be little or much distended, calling, therefore, for either the palliative or radical method of treatment.

The Anatomical Points.—The vas deferens, the three arteries, and the two sets of veins constitute the most important structures of the cord. The vas deferens is a round, white, firm, incompressible structure, an eighth of an inch in diameter, easily recognized, as it lies at the posterior aspect of the spermatic cord. The spermatic artery lies in front and (Figs. 1662 and 1663) the artery of the vas at the side of the vas deferens, and the cremasteric artery among the superficial layers of the cord at the outer side. The spermatic veins and those of the vas run upward, the former being the larger, the more numerous, and lying in front; the latter the smaller, and attendant on the vas deferens. The veins of the left are larger than those of the right side, and usually the spermatic veins of either side are affected much oftener than are those of the vas deferens. An abundance of connective tissue is present between the structures of the cord. Spencer's cut illustrates the relation of the structures in an admirable manner (Fig. 1664).

The Palliative Treatment.—The palliative treatment consists in raising the scrotum and its contents, thus lessening the traction on the cord of the column of blood contained in the vessels. This plan of treatment is effected by the various forms of sus-

FIG. 1665.—Morgan's suspensory.

pensories, as Morgan's (Fig. 1665), and the one in common use. If these measures relieve the urgent symptoms, an operation may not be desired. If, however, the characteristic symptoms recur or continue, then, if preferred, the palliative operation of shortening the scrotum by excision can be performed.

The Excision of the Scrotum.—The abridgment of the scrotum by excision of the lower portion and repair of the wound raises up its contents and thereby relieves the tension on the cord, the same as by the use of a suspensory.

The Operation.—Thoroughly cleanse the scrotum and anæsthetize the patient; apply the clamp (Fig. 1667) with the bar (*a*) adjusted to the affected side, obliquely to the median rhaphe, by drawing between the blades a sufficient amount of scrotal tissue; press the testicle upward to the external ring to avoid its inclusion by the clamp; tighten the blades of the instrument amply to control the circulation and securely hold the scrotal tissue; transfix the protruding portion of the scrotum on a level with the adjustable bar (Fig. 1667) with a sharp, narrow-bladed bistoury and cut it off (Fig. 1666); pass the sutures through the divided borders (beneath the bar) before the blades of the clamp are

Fig. 1666.—Operation of excision of the scrotum at right angles with rhaphe for varicocele, retention stitches applied; one pair of forceps removed and interrupted suturing begun.

loosened; loosen the clamp and catch and tie the bleeding points with catgut before tying the sutures. Tie the sutures, place the patient in bed, elevate the scrotum, and dress the part with gauze. The wound usually heals quickly, and the result affords a relief that amply recompenses the patient for the annoyance incurred. If the clamp just described be not at hand, the operation should not be rejected for this reason, as a clamp of practical

Fig. 1667.—Henry's scrotal clamp.

utility may be extemporized from long-handled forceps or a pair of curved bladed forceps applied at either side of the scrotum, or by adjusting to the scrotum two narrow bars of metal or stiff wood, the extremities of which can be firmly held by elastic bands or by the hands of an assistant.

The Precautions.—Care should be taken to arrest all bleeding points before the borders of the wound are united, to avo   sive

tion of blood that the loose tissue of the scrotum invites. In case extravasation happens, the blood should be removed at once from the tissues and the bleeding point found and tied.

The Radical Treatment of Varicocele.—The means employed to obliterate the dilated vessels are quite numerous. They all, however, accomplish the result by compression. Only such as are considered consistent with the safety of the patient are here described. It will be noted that in some instances the operation is an open one—the vessels being reached through one or more free incisions. In others, puncturing only is practiced for this purpose.

In each of the operations great care must be exercised to avoid the vas deferens and artery. Therefore it is proper to repeat the fact that they lie posteriorly to the enlarged and wormlike congeries of vessels (page 1449) around which the compression is usually applied. If the patient be caused to lie down with the hips elevated, the blood will return from the varicose
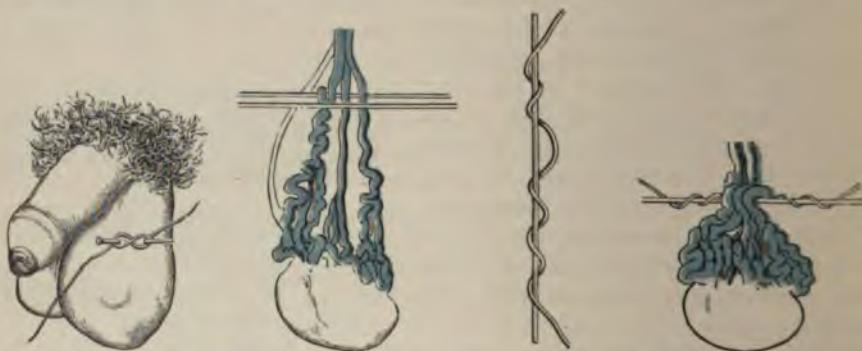
FIG. 1668.—Occlusion by pins. FIG. 1669.—Wires in position. Videl's operation. FIG. 1670.—Wires twisted. Videl's operation. FIG. 1671.—Vessels occluded. Videl's operation.

veins into the general circulation, after which the vas deferens and the artery can be easily isolated and separated from the veins. If the patient then assumes an erect position, the veins will again become distended; after which, if pressure be maintained upon the cord at the external ring by any effective agency, the vessels can be distinctly outlined with the patient placed again in the recumbent position. The operator having thus carefully isolated the vas deferens and the artery, the patient can be etherized and the operation performed.

The Compression with Pins (Fig. 1668).—Compression with pins consists simply in passing a strong pin through the scrotal tissues in front of the vas deferens and the artery and behind the varicose veins, and throwing around its protruding extremities, so as to include the tissue in front, an elastic ligature, or cotton yarn, drawn sufficiently tight to cut off the circulation. This procedure should be repeated at a distance of about one inch from the site of the first application. The pins can be withdrawn at the end of three or four days.

The Compression with Wires (Videl).—The treatment by compression

with wires is made by passing a stout wire either in front of or behind the veins—preferably the latter—then passing a second but smaller one at the opposite side, but through the same openings in the integument (Fig.

FIG. 1672.—Keyes's double-eyed needle.

1669). The wires are then twisted together till the veins are thoroughly compressed and rolled around them (Figs. 1670 and 1671).

Erichsen modified this method somewhat by making an incision half an inch in length at the front and at the back of the scrotum, through which a needle armed with a small silver wire is carried backward in front of the vas déferens and the artery, thence forward beneath the integument around the enlarged veins, and the ends of the wire twisted together so as to constrict firmly the included vessels. Daily tightening of the grasp of the wire is practiced for a week or ten days, or until the vessels are severed by the process of ulceration.

Durante exposes the pampiniform plexus, introduces beneath one or more veins at the lower end a No. 0 catgut ligature, ties it, then passes and repasses in opposite directions the end of each ligature upward beneath the well-developed varices to the external ring, ties the ligature, fastens it beneath the ring, thus gathering up and strangling the veins, and suspending them with the cord and testicle. The wound is then closed.

Keyes's Method.—A needle with a fixed handle, having two eyes at the point, one behind the other (Fig. 1672), is armed with two aseptic ligatures, one carried through each eye. The ends of the posterior ligature are tied to form a loop; the anterior ligature is permitted to hang loosely, with an equal portion at each side of the needle. The enlarged veins are isolated, and the point of the needle is pushed through the scrotal tissues at one or more situations in close contact with the posterior surface of these vessels (Fig. 1673). One end of the untied ligature is then drawn through the tissues with forceps, and caused to remain in this position, while the needle is withdrawn sufficiently to permit its point to be carried in front of

FIG. 1673.—Keyes's operation for varicocele. Passing ligatures with single-eyed needle at different situations.

the distended veins, and out again through the original point of exit, when the distal end of the untied ligature is passed th   vanced portion of the looped ligature, and drawn by it bac   point of entrance to the scrotal tissues by the

94*

needle. The deposited ligature is then freed from the scrotal tissues by making one or two sharp pulls upon it, tied firmly around the veins, its extremities cut short and allowed to disappear within the scrotum. If thorough antiseptic precautions be observed, the ligatures will rarely cause subsequent local trouble.

FIG. 1674.—Ricord's loops.
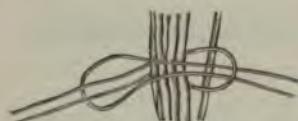
The Double-loop Compression of Ricord (Fig. 1674).—This plan is an excellent one of the kind, and can be readily executed by passing a needle armed with a silk ligature between the veins and the vas deferens and artery; to this is fastened a double ligature, which is drawn through and left in position. The needle with its silk ligature is then passed in front of the veins in the opposite direction, entering and emerging at the points previously made. A second double ligature is then drawn through and left in position. The extremities on the respective sides are now tucked through the loops on the same side, and drawn tight and tied over a narrow antiseptic roller or piece of elastic tubing. The ligatures will cut their way through in five or six days.

Free Incision with Excision (Howse).—In this operation the superficial veins are exposed by direct incision and careful isolation, and a segment of an inch or so is removed independently, between two catgut ligatures, from each of them.

The Operation.—After strict antiseptic preparation in all respects, cause an assistant to grasp and gently draw downward on the testicles of the affected side to make the cord tense; make an incision an inch and a half in length over the most prominent part of the varicocele; draw the borders of the wound apart and carefully expose the veins for an inch and a half by blunt dissection, avoiding severance of the cremaster muscle and exposure of the vas deferens and its vessels (Fig. 1675); hook up the exposed veins and pass around them, an inch and a half apart, two catgut ligatures; tie the lower ligature first, and remove with scissors the included portion of each vein, after tying the second; wash the cavity of the wound with

FIG. 1675.—The operation of excision, Howse's method.

an aseptic fluid, unite the borders without drainage, and dress the part antiseptically. The patient is kept quiet for two weeks, and a week later may return to business, wearing a suspensory for a month or so thereafter.

Bennett's Modification of Howse's Method.—The modification of Bennett

contemplates the permanent shortening of the cord by the removal of the connective tissue and muscles, along with the dilated superficial veins. The amount to be removed should correspond to the abnormal lengthening of the cord, as estimated by the comparative pendency of the testicle.

The Operation.—Through a free incision expose the fascia that directly surrounds the varicocele; carry around the varicocele outside of this fascia, at an estimated distance apart, two long, strong catgut ligatures; tie the ligatures firmly around the included tissue, and resect it at about a quarter of an inch from the points of constriction (Fig. 1676); bring the ends of the stumps together, and hold them there by tying to each other the ends of the respective ligatures, supplemented by a catgut stitch or two, if needed; cut the catgut ends short; close the wound without drainage, and dress it as before. The writer has employed this method in several instances with entire success.

The Precautions.—In order to avoid impairing the integrity of the testicle, the vas deferens and the artery should not be disturbed in any of the operations, nor should the veins of the vas be treated unless decidedly varicose, which is infrequent. There is danger of transfixion of a vein in the passage of the needle, fol-

FIG. 1676.—Operation for cure of varicocele. Bennett's modification of Howse's method.

lowed by extensive hæmorrhage into and sloughing of the scrotal tissues. The writer has met with an instance of this kind in his own experience. Thorough antiseptic methods should be practiced in each variety of procedure, to avoid the complications of infection. If the vessels become extensively thrombosed, confinement in bed for a longer time is required.

The Remarks.—The operation of free incision with excision is attended with no uncertainty in technique. But the obscurity attending the utilization of pins, ligatures, and wire is objectionable because of the blindness of the procedure. The injection of a few drops of a weak solution of cocain at the seat of puncture will minimize the pain of application of pins and ligatures. The tying of subcutaneous ligatures causes momentarily severe pain, sometimes attended with nausea and faintness. If the patient be caused to stand in a warm room, the veins will soon become distended. Pressure on the cord at the external ring, with the patient in the recumbent posture, is followed by a similar result. Only the superficial veins—pampiniform plexus, as a rule—should be treated. The cremasteric artery is always, and the spermatic artery is often, included in the constriction by the indirect method (Figs. 1662 and 1663).

95

The Choice of Operation.—Subcutaneous ligaturing will be the choice of those who object to the employment of anæsthesia. The writer has practiced Keyes's method frequently, with but one unfavorable result, which has been already mentioned above. Latterly, however, the excision plan has given us entire satisfaction, and possesses the advantage of a definite knowledge of the tissues involved. The difference in the comparative length of the periods of recovery in either instance is not sufficient to exercise a controlling influence in the selection of the plan of action. Notwithstanding the extremely satisfactory results thus far obtained by us in the excision methods, we are not blind to the possibility that gangrene may happen from impaired circulation in the part below. We therefore disturb the tissues during dissection as little as possible, and leave unimpaired two or more of the smaller veins in debilitated subjects and those with unusually pendulous tissues.

The Results.—Local septic complications may follow, especially in the absence of requisite antiseptic technique. With proper care, the danger to life from the operation is insignificant. The prognosis for cure is always good, but much better in excision than in the other methods.

The Repair of the Vas Deferens.—Division of the vas deferens during operation for hernia, or injury of it from severe contusion of the cord, may call for repair of the damaged structure. The technique of restoration employed in the surgery of the ureter is of equal utility in the repair of the vas deferens (page 1047 *et seq.*). However, as yet but little has been done in this direction for apparent reasons.

Elephantiasis of the Scrotum.—Elephantiasis of this structure is comparatively rare, occurring more often in the colored than in the white race. The growth is commonly a disfigurement, and often becomes so cumbersome as to impede locomotion. If the cause exist only in the scrotal lymphatics the removal of the mass will effect a cure, otherwise only palliation will be effected. Shock and loss of blood are the especial dangers of operation. However, in the young and in fairly vigorous subjects the outcome is excellent.

The Preparatory Steps.—After the requisite general treatment with stimulants, etc., and local antiseptic measures, place the patient on the operating table on the back, and remove him to the place of operation, especially if the tumor be a large one; raise the growth well above the patient and fasten it thus to permit the outflow of the blood and lymph and the return to the abdomen of a complicating hernia; asepticize thoroughly the field of operation and mark out the lines of the proposed incisions—i. e., if possible—where the healthy and diseased tissues meet.

The Operation.—Anæsthetize and bring the patient to the edge of the table, placing him in the lithotomy position; control hæmorrhage by passing firmly around the root of the tumor (crossing at the pubis) to the opposite sides of the body the ends of a strong rubber tube, tying them together securely behind the back; cause an assistant to support the tumor in the manner to facilitate the operative steps; pass a long grooved director through the preputial fold upward as far as possible and cause the end to press strongly against the overlying tissues; make a free incision down upon

the end of the instrument and push the end through it; divide from above downward along the director the overlying tissues, thus exposing the glans penis; seize the glans with the fingers and free the organ by blunt dissection from contiguous tissues for four or five inches; wrap the penis in antiseptic gauze and draw it aside; make an incision at each side from over the spine of the pubis downward sufficiently to expose the cord down to the testicle; free the testicle and cord from their connections by blunt dissection, wrap them in gauze and carry upward on the abdomen; divide transversely in front the tissues intervening between the incisions at either side; carry (with a long knife) an incision from that made down upon the right cord, downward between the scrotum and perinæum, thence upward at the left side, ending at the incision made upon the left cord; sever with free strokes the tumor from the body, while carefully holding the constricting tube in place; relax the tube, seize and ligature the bleeding points as they appear, cut away the indurated portions, and remove the testicles if hopelessly diseased; arrest oozing with hot, wet compresses; unite the borders of the perineal wound, if conditions will permit. wrapping in the testicles if practicable; surround the penis with gauze saturated with carbolated oil, and dress the remaining raw surfaces in the usual manner; provide a suitable exit for urine, and support the parts along with the superimposed dressings with the common T-bandage, dressing them thereafter as granulating surfaces are treated at other parts of the body.

The Precautions.—The surface of the entire mass should be thoroughly cleansed and wrapped in antiseptic dressings before the operation is begun. The rubber constriction tubes should be securely fastened in place by strips of bandage carried upward and fastened before the incisions are made. Preparations for saline transfusion should be at hand before the operation is commenced. The presence of a hernial protrusion should be determined before amputation is practiced. Urinary discharges should be carefully excluded from the wound throughout the course of repair.

The Remarks.—In large tumors the length of the cord is often considerable, rendering the location of the testicle somewhat problematical. If sufficient amount of healthy tissues be at disposal, the penis and testicles should be properly surrounded, otherwise stem grafting may be practiced then or at a later date.

The Results.—Only about five per cent die from the operation. The parts usually heal promptly, the penis and testicles being covered with cicatricial tissue if not otherwise better provided. Sometimes the disease returns, usually more or less slowly, the patient remaining comparatively free for a term of years. If the testicles are unaffected their function is not necessarily impaired by the operation and its sequels.

CONGENITAL MALFORMATION OF THE URETHRA.

The urethra may be absent or occluded; it may be extremely small or bifid; the external opening may be higher or lower than normal, and even double; its walls may be deficient above or below, constituting epispadias and hypospadias respectively. Epispadias is sometimes complicated by sepa-

ration of the symphysis pubis and exstrophy of the bladder.   In many
instances these deformities are a great affliction during life, and later often
become especially so when the sexual gravity of the deformity is realized.

The operations are performed easier and with better success after the
period of infancy, as then the patient is the better controlled and the organ
of a larger size. Responsive co-operation is best secured when the patient
suffers from the chagrin incident to the appreciation of the importance of

FIG. 1677.—Instruments employed in repair of urethral defects.

a. Small scalpels. b. Bistoury. c. Fine-pointed forcipressure. d. Mouse-tooth and
    dissecting forceps. e. Needle-holder. f. Short blunt-pointed, straight and curved
    scissors. g, h. Single and double tenacula. i. Steel sound. j. Flexible catheter.
    k. Long silver probe. l. Traction loops. m. Small straight and curved needles.
    n. Langenbeck's clamps. o. Horsehair, silkworm gut, and catgut. p. Small strip
    of board and pins, to which the penis is confined during repair. q. Perforated shot.

the deformity. The preparatory measures in the treatment of these deformi-
ties refer more especially to the general fitting of the patient for the pur-
pose and to the requirements of special complications demanding independ-
ent action, as exstrophy of the bladder. The preparatory treatment of the
individual operations will appear under the proper titles.

Hypospadias.—Hypospadias results from a deficiency in the floor of the urethra. The opening may be in the glans, or in the penile or scrotal portions. The first form is the most frequent and the least important. The scrotal, with and without perineal involvement, is the next in point of frequency, and the most important of all. They may be designated, therefore, as balanic, penile, and scrotal hypospadias respectively. Mixed varieties of this deformity, such as glandulo-penile, peno-scrotal, and perineo-scrotal (page 1475), are sometimes seen.

The Preparation.—Before the operation the urine should be drawn and the parts thoroughly cleansed. Chloroform anæsthesia is advisable if no contraindications to its use be present. The penis is then confined to the strip of wood (Fig. 1677, *p*) by means of the pins passed through the cutaneous borders of the organ, in order that it may be the better controlled during the manipulative measures.

Gouley's Method (Fig. 1678).—Gouley's method is especially applicable to the balanic variety.

The Operation.—Make two longitudinal cuts at either side of the penis, *a, b* and *a, b*, far enough apart to leave ample material for the new urethra; make cuts *c, d* and *c, d, a, b*, a quarter of an inch outside; remove the integument of the spaces bounded by these incisions; leave undisturbed the skin and mucous membrane included between the incisions *a, b*; slide the loose skin at the root of the penis

FIG. 1678.—Gouley's method.

and of the scrotum forward, making the flap double upon itself, until *b, b* is brought forward to *a, a* and the denuded surfaces at the sides of the penis are brought in accurate apposition with the borders of the reflected flap, making the angle of the fold at *e, e*. The first suture is taken at *g*, and passes from within (beneath) outward through the reflected part of the urethral flap, thence from without inward through the lower and unreflected portion to near the point of starting, thus uniting together near to the point of folding the reflected and unreflected portions of the urethral flap. Before tying, pass the suture of the opposite side in the same manner; tie both, cut the ends short, leaving the knots inside the new urethra; introduce sutures along the external borders, uniting them closely together. The newly formed meatus is transverse, its under lip being the fold of the skin from *f*, formed by the apposition of the points *b, b* to *a, a*. If curved the organ should first be straightened (page 1460).

Anger's Method (Fig. 1679).—Anger's method is a commendable procedure for the repair of deformity at the penile portion only. The general and special preparatory measures of the preceding plan are of equal importance in this one.

The Operation.—Make an incision at the left side of the penis, from the glans to the scrotum, *a, b*, half an inch from the median line; also incisions
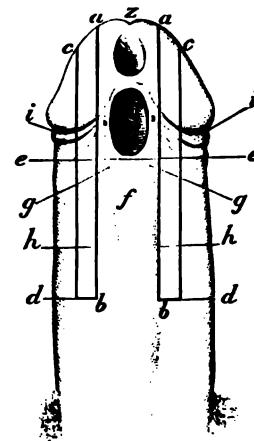
at a, c and b, d. The flap thus formed, x, is dissected up, its base being attached near to the median line, c, d. A second longitudinal incision, e, f,

FIG. 1679.—Anger's operation for hypospadias, first step.

FIG. 1680.—Anger's operation for hypospadias, second step.
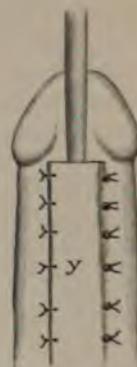
FIG. 1681.—Anger's operation for hypospadias, third step.

is made at the right side of the median line, near to it, and of the same length as a, b, with lateral incisions an inch and a half long at each extremity, f, g and e, h (Fig. 1679). The flaps are raised, a sound introduced into the urethral groove, and the first flap, x, turned over it, bringing the integumentary portion in contact with the sound (Fig. 1680). Independent sutures, each armed with a needle, are passed through the free margin of the first flap, x, and outward through the base of the second flap, y, and fastened

FIG. 1682.—Duplay's method for hypospadias. Forming flaps.

by shot pressed around them (Fig. 1681). The remaining flap, y, is then placed upon the raw surface of the first, x, and fastened to the margin of the first incision, a, b, in a similar manner or by sutures. The sound or catheter is then removed.

Duplay's Method.—Duplay's method is divided into three steps: 1. If the penis be incurved, it is straightened and a new meatus made. 2. The missing portion of the urethra is restored. 3. The old and new parts are joined together.

The penis is straightened by making transverse subcutaneous incisions through the restraining bands while the organ is being extended; if the integument be too taut to admit of the proper rectification, it, too, must be severed. The resulting cuts are united in the long axis of the penis, or treated by skin grafts or sliding flaps (Bouisson). At four years of age this step is well suited, and the penis confined in

the corrected position a sufficient time to permit the healing of the wound before the second step of the operation is attempted. It may be necessary
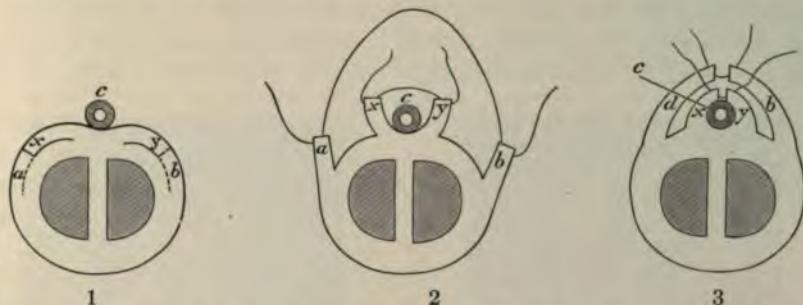
FIG. 1683.—Duplay's method, transverse section. 1. Showing relation of flaps. 2. Reflected. 3. Flaps nearly apposed.

to repeat this corrective measure two or three times before the proper position of the organ is gained. At all events, eight or ten months will no doubt elapse before the organ is properly suited for the final step of the operation.

The first step is completed by freshening, and, if necessary, deepening the urethral groove at the situation of the proposed meatus, and uniting its raw surfaces with silkworm gut or carbolized silk around a sound or gum catheter, as in Thiersch's method (page 1472).

The Second Step.—Pin the penis to the strip of wood (Fig. 1677, *p*) and make two longitudinal incisions, *a, a'*, extending from the glans to near the
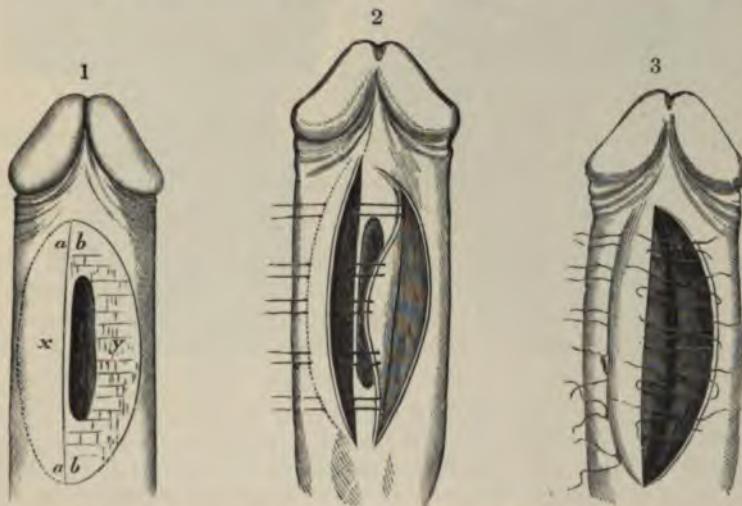
FIG. 1684.—Szymanowski's method of closure of large defects in urethra.

abnormal opening (*z*), one on each side of the urethral groove, at a distance from each other equal to ·· ····· in half the circumference of the

proposed urethra, a dimension which can be ascertained by measuring the gum catheter over which the flaps are to be reflected. From the ends of each of these a transverse incision is made toward, but not quite to, the median line. The flaps, x and y, are dissected up and turned inward over a gum catheter, c (Fig. 1683), and their margins fastened together in the median line by fine catgut sutures (x, y). The outer flaps, a and b, of the

FIG. 1685.　　　　　　　　　　　FIG. 1686.

FIG. 1685.—Operation for hypospadias, Beck's method. Flaps formed, urethra mobilized. Incision in deep groove for end of urethra.

FIG. 1686.—Operation for hypospadias, Beck's method. Flaps united. End of urethra sutured to glans penis.
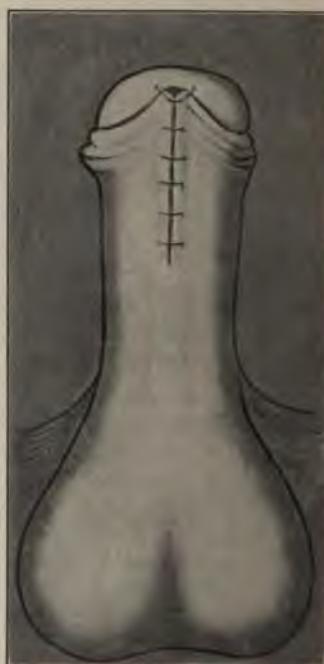
longitudinal incision are dissected up at the ends and sides sufficiently to permit them to be easily drawn over the reflected flaps, x and y, when they, too, are united in the median line by interrupted or continuous sutures. The quilled suture (Fig. 144), with shot fastening, is admissible for the purpose. Unite the anterior extremities of all the flaps to the raw borders of the glans, thus completing the anterior portion of the tube. Patients of four to six years of age are suited for this step.

The Third Step.—The third step is delayed for three or four months, or at least until the suitable repair of the preceding ones is established. Then the edges of the abnormal opening at the base of the penis (z) are freshened and united over a catheter by means of deep quilled and superficial interrupted catgut sutures. In the absence of indications to the contrary, the catheter may be permitted to remain during recovery.

Szymanowski's Method (Fig. 1684).—Szymanowski's method is an ingenious and efficient plan of closure of large congenital and acquired urethral defects.

The Operation.—Make an incision, *a, a*, near the edge of the fistula, extending half an inch beyond it at either end; dissect up from within outward a flap (*x*) bounded by the dotted line; make a curved incision, *b, b*, at the opposite side, its length being a trifle less than that marked by the dotted line of the opposite side, but otherwise of sufficient width to cover the fistula and reach the dotted line when turned upon itself; scrape the cuticle from the flap, *y*, and dissect it up to the edge of the fistula; arm each end of a fine carbolized silk suture with a small curved needle; pass these two needles from the epidermic surface, about a quarter to a sixth of an inch apart, through the edge of the curled flap (Fig. 1684, 2), introducing them from within outward—corresponding to the dotted line—through the base of the flap (*x*) formed by the straight incision; after passing a sufficient
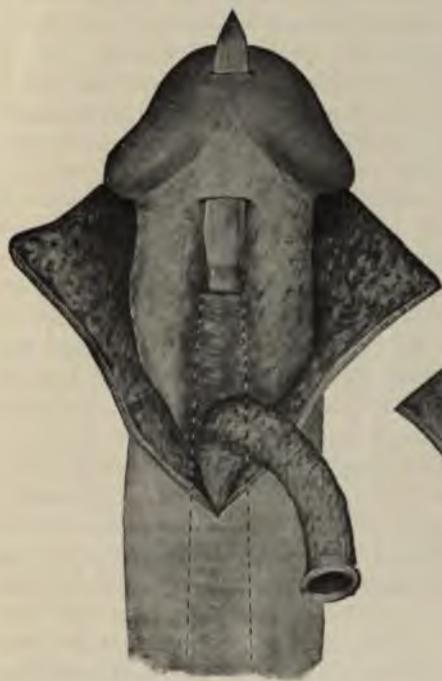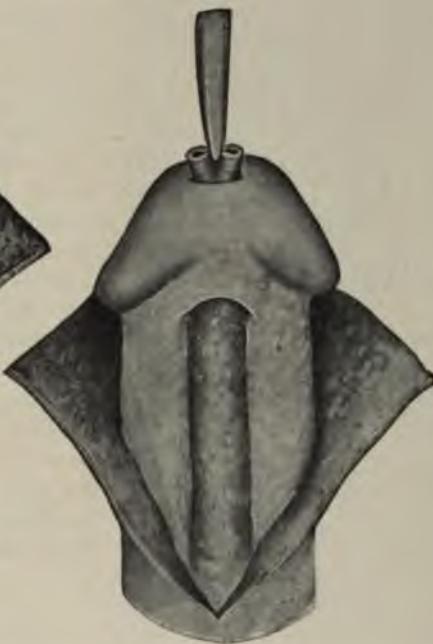
<table>
<tr><td>FIG. 1687.</td><td>FIG. 1688.</td></tr>
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FIG. 1687.—Operation for hypospadias, Beck's method. Flaps and urethra completely mobilized, the shallow groove, the glans transfixed to receive end of urethra.

FIG. 1688.—Operation for hypospadias, Beck's method. End of urethra drawn into place and held with forceps for fastening with stitches.

number of these sutures—one every quarter inch—draw the curved flap beneath the straight one into the space formed by the separation of the latter, so that its edge will correspond to the dotted curved line (Fig. 1684, 3),

and secure the sutures over a piece of quill or cork, or fasten them with shot. The inner edge of the straight flap is now united to the outer edge of the curved one, and the operation is completed.

Mayo [*] (C. H.), in a comprehensive analysis of operations for hypospadias, adds the weight of his experience to the following methods of practice:

Beck's [†] Method.—Beck, instead of forming a new urethra, dissects free and displaces forward the old one, thus obviating many of the disagreeable features of other methods of treatment (Fig. 1685).

The Operation.—Make an incision from the center of the abnormal opening backward to the posterior third of the pendulous portion of the organ; encircle the neck of the penis immediately below the coronary sinus (Fig. 1685) with a nearly transverse incision carried through the integument while the glans is stretched upward; dissect back the flaps thus formed, exposing the distal third of the penis; dissect the urethra and the corpus spongiosum (Fig. 1685) completely backward from the corpora cavernosa until the end of the exposed urethra can easily be brought to the top of the glans penis; make a lateral incision along each side of the groove of the glans (Fig. 1685), forming thereby two flaps of sufficient length to readily encircle the end of the urethra when adjusted to the bed of the wound thus formed; fasten the end of the urethra to the top of the glans by four silk sutures (Fig. 1686), and unite with each other and with the end of the urethra the flaps formed from the glans; also unite the borders of the transverse skin incision longitudinally, thus improving the cosmetic result (Fig. 1686). The glans may be prepared to receive the urethra by transfixion with a thin-bladed knife and the end of the urethra drawn through the opening into place and fastened (Figs. 1687 and 1688) and the skin flaps sutured (Fig. 1689). *Beck,* however, regards this plan less favorably than the former.

FIG. 1689.—Operation for hypospadias, Beck's method. End of urethra sutured in place after transfixion plan. Flaps sutured, completing operation.

The Remarks.—The tunneling of the glans by transfixion is better suited for cases with but little or no groove of the glans or with cicatricial infiltration there. Beck's plan of practice is applicable to all ages, remembering that infantile tissues are more subject to soiling and less virile than are the older. A rubber catheter or a dilator can be passed into the urethra and used as a handle, thus facilitating the procedure.

In perineal hypospadias the mobilization of the urethra can not be accomplished. In a case of this kind a large inferior flap may be formed (Fig. 1690) of sufficient width to encompass a catheter of proper dimen-

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[*] Jour. Am. Med. Association, April 27, 1901.
[†] Jour. Am. Med. Association, December 9, 1900.

sions to form a urethra, around which instrument the flap is wrapped and its base united with fine chromicized catgut sutures, thus forming a new urethra (Fig. 1691), which is held in place and the wound covered by a flap of suitable shape raised from the anterior surface of the scrotum, turned upward, adjusted, and joined with sutures to the borders of the wound so as to bring the raw surface upward (Fig. 1692).

Rosenberger denudes strips of integument at each side of the urethra (Fig. 1693), which are continued on to the abdomen or the scrotum, depending on the nature of the defect (Epispadias (Rosenberger) or Hypospadias (Landerer and Bidder)) to be treated (Fig. 1693). In each instance the denuded surfaces are sutured together, and when suitable union has taken place the flaps are detached from the original site, thus establishing repair, which later site is treated by suture or skin grafting.

Van Hook devised the use of redundant foreskin for the construction of an urethra, which idea is utilized by Mayo as follows: Extend the prepuce as for circumcision, and make two parallel incisions about an inch apart from the free border of the prepuce to its attachment to the neck of the penis; unfold the prepuce, thus forming a loop of skin about two and a half inches in length; extend the incisions along the dorsum, if the fold be not already of adequate length for the purpose; connect the ends of the two incisions by a transverse one and lift the flap, leaving it attached at the neck of the penis; close the denuded area by means of sutures; form the flap into a tube by uniting its borders with catgut sutures, bringing the cutaneous surface within (Fig. 1694); tunnel the penis with a narrow bistoury or a median-sized trocar and cannula from above the groove to a point beneath the abnormal opening, causing it to emerge at one side of, but close to the urethra; draw through the opening thus made the cutaneous urethra, suturing it at the point of entrance and of exit (Fig. 1695).

In about ten days the pedicle is divided. *Later* insert through a perineal opening into the urethra a Jacobs self-retaining catheter (Fig. 1695), and complete the operation by joining the contiguous ends of the urethra by suturing or by mobilizing

Fig. 1690.—Operation for perineal hypospadias. Wood-Beck flaps. Duplay-flaps marked out, distal flap partly raised.

(Beck) the proximal portion of the urethra until its extremity can be inserted into and fastene͏ ͏ ͏rt with sutures and the united part covered in with inte͏

Nové-Josserand-Ro͏ urethra is supple-

mented by a new portion made from the integument at the inner surface of
the thigh and introduced into place over a catheter. *Rochet* modified this
step by taking a flap from the anterior aspect of the scrotum with base at
the urethral orifice.

The Operation.—Make a transverse incision four-fifths of an inch long
just in front of the abnormal meatus; introduce through the incision and
pass forward along the under surface of the penis in the subcutaneous con-
nective tissue to the base of the glans a stout probe, thus elevating the skin
along the entire route; slit up with a knife or tunnel with a trocar and can-
nula the inferior portion of the glans; make from the integument of the
anterior aspect of the scrotum, and of the penis up to the abnormal opening
(Fig. 1696), a sufficient flap to surround a woven catheter of suitable size
(21 F.) to meet the requirements of the new urethra; sew the flap around
the catheter with the cutaneous surface innermost and pass the free end of
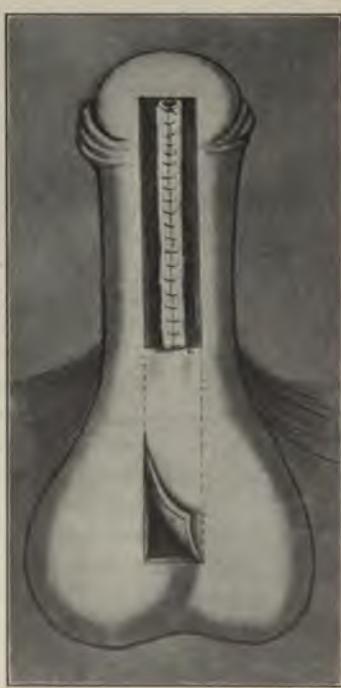
FIG. 1691.   FIG. 1692.

FIG. 1691.—Operation for perineal hypospadias. Duplay-Beck flap. Urethra formed,
dissection of overlying flap began.

FIG. 1692.—Operation for perineal hypospadias. The overlying Beck flap in place,
lower wound unclosed.
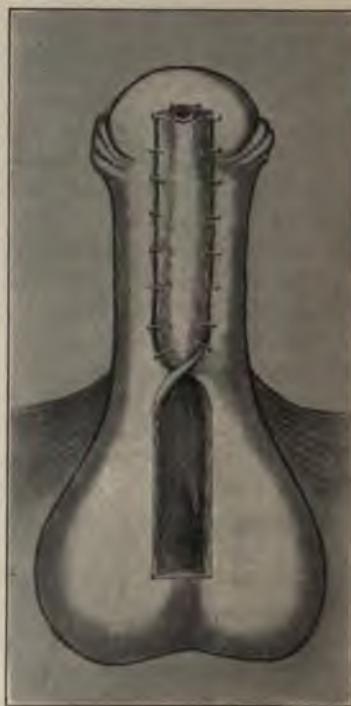
the instrument along the channel made by the probe until the advancing
end of the urethral graft appears at the new meatus, when the anterior
ligature is cut and the graft is sutured to the glans penis (Fig. 1697);

push the catheter into the bladder, and retain it there to permit ready escape of urine; close with sutures the wound of the scrotum and penis; apply a snug dressing to the organ while held in the erect position.

The Remarks.—The catheter may be retained until the wound is healed (seven days) unless contraindication arise. After three or four days more

Fig. 1693.—Operation of perineal hypospadias. Rosenberger, Landerer and Bidder method.

a sound should be passed and this measure repeated for some time (three or four weeks) to obviate undue contraction of the new channel.

This is an ingenious operation which has proven successful on several occasions. Should a fistula arise at the seat of junction of the old and new portions of the channel proper union of the two can be attained the same as in the preceding instance.

The General Remarks.—The use of the scrotal and preputial tissues for primary reparative flaps is not advisable, unless flaps from other sources are out of the question. *Pringle* * reports the transplantation of bullock's urethra for cure of congenital and acquired defects of the human urethra with encouraging success. The peculiar structure of these tissues interposes an obstacle to prompt healing by reason of œdematous swelling and corrugation. However, when necessary, these tissues can be employed with satisfaction to close small openings directly, or to supplement the use of the more reliable structures. It is wise to correct the penile deformity as early as possible, in order to stimulate its growth to the fullest extent. The buried sutures should be of catgut, the others of silkworm gut or horsehair. The raw surfaces should be accurately apposed, and the sutures not tightly drawn. If the line of apposition be puckered in places, primary union there will fail to take plac~~   ~~nvasation of urine may occur and small

mber, 1904.

troublesome fistulæ follow. Usually, however, these fistulous openings heal quite readily at a later period with instrumental dilatation of the urethra. After union of the borders of the wound, the organ is dressed lightly with iodoform gauze and carefully supported in the most comfortable position.

Fig. 1694.—Operation for hypospadias. Van Hook's method, redundant foreskin employed for urethra.

The application to the borders of a narrow dressing of iodoformized collodion protects them from external infection and holds them steadily in place. But if this dressing contract overmuch, the urinary channel may be narrowed and the escape of urine correspondingly impeded, especially if much swelling takes place. The retention in the bladder of a rubber catheter for two or three days is sometimes practiced with satisfactory outcome. However, the irritation of the instrument and the escape of urine along the side may produce much trouble, and require a prompt withdrawal. The passing of several horsehairs or threads of silkworm gut through the urethra along the catheter and out of the perineal opening affords good drainage. The charging of the urethra with sterilized oil at the time of introduction, will do much to lessen and perhaps may obviate these dangers entirely. The writer has practiced the injection of a small amount of sterilized oil into the urethra before each alternate act of micturition, for two or three days, with excellent results. The repeated introduction of the

catheter at this time is objectionable, especially if much swelling be present, not only because the advancing end imperils the line of union, but the opposition of the patient may cause tearing asunder of the wound.

The Results.—The dangers to life with proper care are insignificant, indeed. The usefulness of the organ is much enhanced if the operation is done as early in life as possible. The general results in older subjects are more disappointing in the final outcome than are those of the younger. Not infrequently a small and even persistent fistula may follow a failure of union at some point, but the repeated use of sounds will frequently assist and also add to the completeness of the cure by increasing the capacity and establishing a uniformity of the diameter of the urethral canal.

Epispadias.—Epispadias results from a deficiency in the roof of the urethra. This deformity is less frequent, but more troublesome and difficult to cure than hypospadias. In this also the penis is dwarfed and curved. In some instances the opening into the bladder is exceedingly large and

FIG. 1695.—Operation for hypospadias. Van Hook's method, foreskin to complete urethra.

incontinence of   ' present. However, urinary control often results
from operatio   mcts it can not be regarded as suc-
cessful. The   ry results in this as in the pre-
ceding defor

The general and special preparation of the patient and the parts, and the attention to details during and after operation, are substantially those employed in hypospadias. It should be noted at this time especially that the principles of repair are similar in hypospadias and epispadias. In fact, many of the steps of operations for cure of the former defect are equally efficient in remedying the latter.

Nélaton's Method (Fig. 1698).—Draw the prepuce down over the end of the penis and hold it there with a ligature during operation; adjust the

Fig. 1696.—Operation for hypospadias. Nové-Josserand-Rochet method, urethra formed of integuments ready for drawing into place.

Fig. 1697.—Operation for hypospadias. Nové-Josserand-Rochet method, integumentary urethra drawn into place.

penis to the strip of wood (Fig. 1677, *p*); pin it in place and make a longitudinal incision along each side of the urethral gutter, *a, a'*, at the junction of the skin and mucous membrane, from the corona glandis to the abdominal wall; make a right-angled transverse short outward incision from the ends of each of the longitudinal ones, two or three lines in length; dissect

outward from the exterior lip of each incision, *a, a'*, to the outer limits of
the transverse incisions, forming two flaps, *x*
and *y*; mark out a third flap on the abdominal
wall, *z*, by carrying upward from the outer
limits of the proximal transverse incision two
parallel incisions, *c, e'*, connecting them above
by a transverse cut; reflect the abdominal flap,
z, downward so as to form the roof of the new
urethra, the cutaneous surface being under-
most; unite over a catheter the parallel borders
of the abdominal flap, *z*, to the inner borders
of the primary incisions, *a, a', a, a'* (Fig. 1696);
re-enforce the abdominal flap, *z*, by a scrotal
one (Fig. 1698, *f*) limited above by a curved
incision circumscribing the under half of the
organ at the peno-scrotal junction below by an
incision, *f'*, parallel with the first, located the
length of the penis beneath the upper one, and
each extremity remaining continuous with the
integument of the outer surface, *e*; dissect the
flap up, slip the penis under it, and bring the
raw surfaces of the flaps (*f* and *z*) in contact with each other; unite the
borders of the scrotal flap to those of the penile flaps, *x* and *y*, at *g, g*, and
close the abdominal and scrotal wounds with sutures.

FIG. 1698.—Nélaton's method
of operation for epispadias.
Formation of abdominal (*z*)
and penile flaps (*x, y*).

The Remarks.—The hair bulbs of the proposed abdominal flap should
be destroyed, and the part allowed to heal before the flap is made, to avoid
the subsequent annoyance of the capillary growth. The width of the abdom-
inal flap should exceed somewhat the
distance between the penile parallel in-
cisions, *a, a*, in order to establish a
capacious urethra. Fine sutures of
silk or of chromicized catgut may be
employed. If urine escapes by the side
of the catheter, or the instrument
causes irritation, it should be removed
at once, and the case treated as in
hypospadias.

The After-treatment.—An aseptic
and well-oiled catheter is introduced
and fastened in the urethra; the parts
are dusted with iodoform, and a light
gauze dressing is applied from time
to time as needed. The bladder should
be drained through the catheter, if pos-
sible, in the manner already described

FIG. 1699.—Nélaton's method of opera-
tion for epispadias. Formation and
application of scrotal flap (*f*).

(page 1308), and the patient
sutures are removed in a wee
a week.

95*

bedding kept dry. If need be, the
nd the catheter at the end of

The Results.—With aseptic attention there is no danger to life, prompt and satisfactory healing usually takes place, and thereby the local and general conditions are much improved.

Thiersch's Method.—In Thiersch's method a urethra is constructed of more nearly the normal diameter, and the glans penis is covered. This
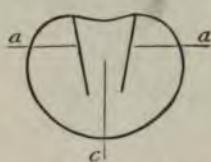
FIG. 1700.—Thiersch's method of operation for epispadias, first stage, transverse section. *a, a.* Converging incisions. *c.* Median portion.

FIG. 1701.—Thiersch's method of operation for epispadias, first stage. Freshening surface of glans.
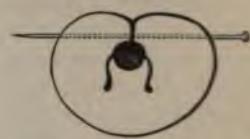
FIG. 1702.—Thiersch's method of operation for epispadias, first stage. Depression of middle portion and union with pin.

procedure is divided into four stages, and requires often several months for its completion.

The First Stage (Figs. 1700, 1701, and 1702).—The first stage relates to the construction of the meatus and the glandular portion of the urethra,

FIG. 1703.—Thiersch's method of operation for epispadias, beginning of second stage. *a, a.* Proximal incision. *a, b, a, b.* Short transverse incisions. *c, c.* Distal incision. *c, d, c, d.* Short transverse incisions. *x* and *y.* Dorsal flaps. *z.* Fistulous opening.

and is practiced as follows: Make a deep converging incision into the glans, three-fourths of its thickness, along each side of the urethral gutter (*a, a,* Fig. 1700); freshen a narrow surface of the outer portion of the glans the entire length of the incisions (Fig. 1701); depress the middle portion with a catheter, and unite together around it the lateral portions at their freshened surfaces, holding them in place with fine needles armed with figure-of-eight sutures (Fig. 1702), or with silkworm-gut sutures.

The Second Stage.—In the second stage the urethra is constructed. This stage is not begun until the objects of the preceding one are completely attained. Then make an incision through the skin and subcutaneous tissue at the edge of the urethral gutter at the right side (*a, a,* Fig. 1703); also a short outward transverse cut from each end, *a, b.* Make a second incision on the left side, parallel with the preceding one, half an inch external to the edge of the urethral gutter, *c, c,* and a transverse one at each extremity, *c, d,* extending inward to the border of the urethral groove. Dissect up flaps *x* and *y* (Fig. 1704), making them as thick as practicable; raise and turn the flap *y* over a catheter in the urethral gutter

so as to form the roof of the new channel, its raw surface being uppermost (Fig. 1705). Pass several sutures through it near to its free margin, thence through the inner border of the first incision, *a*, *a* (Fig. 1703), and fasten

FIG. 1704.—Thiersch's method of operation for epispadias. Beginning of second stage. Transverse section, showing formation of flaps *x* and *y*.

FIG. 1705.—Thiersch's method of operation for epispadias. Ending of second stage. Transverse section, flaps reflected.

them by a quill or shot attachment. The flap *x* is then drawn across the former, so that their raw surfaces are in contact throughout, and its free margin, *a*, *a*, joined to the outer side of the incision, *c*, *c*, by sutures (Fig. 1706).

The Third Stage.—The third stage consists (Fig. 1707) in closing the small opening located between the glans penis and the roof of the urethra (Fig. 1706, *a*). The prepuce is employed for this object in the following manner: Raise up and buttonhole the pendulous prepuce (*b*) at the lowest part, and press the glans penis through the opening; freshen the margins
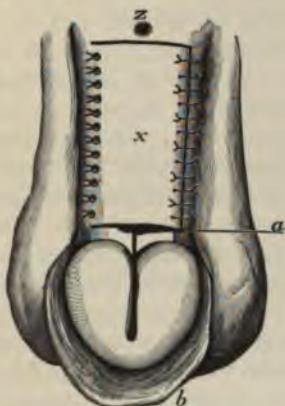
FIG. 1706.—Thiersch's method of operation for epispadias. Completion of second stage. *a*. Anterior defect. *b*. Prepuce. *x*. Dorsal flap. *z*. Fistulous opening.

FIG. 1707.—Thiersch's method of operation for epispadias, third stage. Anterior defect closed.

of the gap on the dorsum, and close it with a flap formed from the reflected prepuce close at hand (Fig. 1707).

The Fourth Stage.—The fourth stage is directed to closing the opening into the bladder (Fig. 1706, ne by means of two flaps—right

and left (Fig. 1708, *a*, *b*). The left (*b*) is taken from the left groin, is triangular in shape, with the base located at the left upper half of the open-
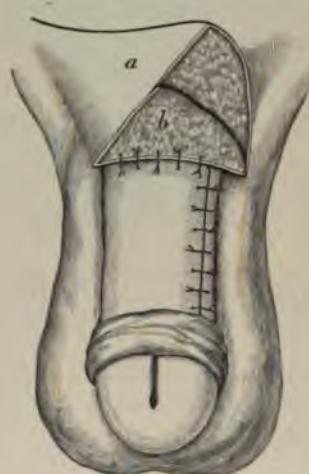
FIG. 1708.—Thiersch's method of opera-
tion for epispadias, fourth stage.
Closure of fistulous opening.
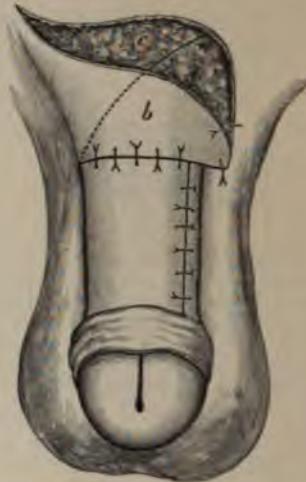
FIG. 1709.—Thiersch's method of opera-
tion for epispadias. Completion of
fourth stage.

ing, and, when turned downward with the raw surface uppermost, forms the roof of the opening (Fig. 1708). Its margins are sewed to the freshened upper border of the new roof of the urethra (Fig. 1709). The right flap (*a*) is longer, and the base is located at the right external abdominal ring. Its raw surface is placed in contact with that of its fellow, and fastened in place with sutures (Fig. 1709) addressed to the contiguous borders. The remaining raw surface (*c*) is permitted to heal by granulation, or repaired by skin grafting.

FIG. 1710.—Duplay's method
of operation for epispadias,
second stage. *a*, *a'*. Fresh-
ened surfaces. *z*. Fistulous
opening.

The Remarks.—A proper interval should elapse between each stage of the operation, to allow of complete repair of the preceding steps and a suitable estimate of their success. Formerly Thiersch established a temporary perineal fistula, but he has since decided that with proper care it need not be made.

Duplay's Method.—In Duplay's, as in the preceding method, the operation is divided into four stages:

The first stage is allotted to the straightening of the penis and repairing the operative defects incident thereto with the greatest aseptic and plastic care, so that additional tissue obstruction will not

follow operative effort. This measure is attained in the manner already described (page 1460).

The Second Stage.—In the second stage the urethra is formed entirely (Fig. 1710) from the central, x, x, penile structures.

A strip of tissue about a quarter of an inch in width is freshened at each side of the urethral gutter (a, a'), and the freshened surfaces are united with each other over a catheter by means of quilled sutures (Fig. 1711). However, if the urethral groove be shallow at the outset, a median incision (a) is made along its whole length to facilitate easier adjustment of the freshened surfaces.

The Third Stage.—In the third stage the prepuce is treated as in Thiersch's method, and so arranged on the dorsum of the organ as to provide a sound cutaneous covering for as much of its distal part as is possible.

The Fourth Stage.—The fourth stage is devoted to the closure of the opening into the bladder. The surfaces of the apposed borders of the gap are freshened and united and held in place by shotted sutures.

The Remarks.—The same aseptic care is exercised in this as in the preceding methods. If permissible, the catheter is allowed to remain in the canal with the end in the bladder until the wound is safely healed. The writer has practiced Thiersch's method repeatedly, and in each instance with entire success. In no case was a temporary perineal fistula made.

Fig. 1711.—Duplay's method of operation for treatment of epispadias. Completion of second stage. *a.* Median incision.

Perineal Hypospadias (*perineo-scrotal*).—This form of hypospadias is the rarest of all of these defects, and the deformity is great and the prospects of success of operative effort more uncertain and protracted than in either of the preceding instances. The conditions of the penis are variable, and often complicating, the organ sometimes being unusually atrophied, strongly incurved, and affixed to the scrotal fissure, thus obscuring the urinary opening. *The operative treatment* relates to remedying the penile portion of the deformity by the stated method suited to the purpose, followed with closure of the perineal defect by direct union or by proper flap procedures.

The General Remarks.—The small and often tense flaps, the urine-soaked dressings, an irritable bladder, a fretful and uncontrollable subject, together with unwelcome physiological manifestations due to irritation and handling of the parts, contribute largely indeed to the failures that so often attend these plastic efforts. Beck's method disposes of the need for the use of a catheter. Perineal section also is sometimes utilized for the purpose. Cleanliness, with bladder drainage, urotropin, and demulcent drinks, may lessen the evil local effects of the urinary soiling. Tunneling of the organ so as to bring the urethra out at a point above the apex of the glans will lessen and perhaps prevent the dov ^ curving that so often follows other methods of action.

ACQUIRED URETHRAL DEFECTS.

The walls of the urethra may suffer loss of substance, producing a fistula. The caliber of the canal may be diminished, causing stricture, either of which usually depends upon acquired causes.

Before attempting an operation for the closure of a urethral fistula the caliber of the canal should be made as near to its normal size as possible by appropriate treatment of the strictures and such other obstructions as may exist in its course.

Urethrorrhaphy.—Urethrorrhaphy is employed to close a small urethral fistula not exceeding a fifth of an inch in diameter, if it be circular, and one fourth if longitudinal. If reasonable success is to be attained, it is necessary that careful attention be paid to every aseptic detail.

Before beginning the operation empty the bladder, and, if necessary, administer an anæsthetic. Local anæsthesia will commonly suffice.

The Operation.—A sound is introduced into the urethra, and the handle given in charge of an assistant. The edges of the opening are carefully pared obliquely from without inward, and, when completed, should present a funnel-shaped appearance, the apex corresponding to the mucous opening of the canal; undercutting is then done, dividing the tissues into two sepa-

FIG. 1712.—Urethrorrhaphy. Tissues undercut, separated, and prepared for sewing.

rate planes (Fig. 1712). The wound is then closed longitudinally by uniting each layer separately (Fig. 1713), the former with catgut, the latter with horsehair, silkworm gut, or silk (Fig. 1714). Closure without undercutting, by means of silkworm gut, horsehair, or antiseptic silk sutures carried down to, but not through, the mucous lining, the intervals between them being short, may be made (Figs. 1715 and 1716).

The After-treatment.—The patient should be kept quiet and given alkaline and demulcent drinks, and the urine drawn with a catheter. It is a wise precaution to inject aseptic oil into the urethra before the introduction of the catheter. The catheter may be introduced before the sewing, and allowed to remain as a guide to the latter, and for the escape of urine thereafter, as long as advisable.

The Comments.—The ill effects of the contact of urine with the freshened borders of the opening emphasizes the wisdom of the establishment of perineal drainage during the healing, unless especially contraindicated. However, in some cases, the catheter can be borne by the urethra long enough to allow the wound to heal, thus avoiding the perineal element of the case. If the catheter be well borne, its use may be supplemented by a rubber tube extending from it to a vessel beneath the bed.

Urethroplasty—Urethroplasty is employed to close larger openings than those within the domain of urethrorrhaphy.

If flaps be dissected upon either side of the opening, and drawn together and joined in the median line, imperfect union is very apt to result on account of their thinness, median contact, and from sluggish granulation process.

Nélaton's Method (Fig. 1717).—In Nélaton's method the edges of the opening are first pared, and then the integument is detached subcutaneously for about an inch around it by entering a long, thin knife blade through a transverse cut just below the opening. The liberated integument is then joined in a longitudinal fold along the median line by means of quilted sutures.

Dieffenbach (Fig. 1718), instead of dissecting subcutaneously, raised two parallel longitudinal flaps, and fastened the middle of their raw under

FIG. 1713.—Urethror-rhaphy. Deep lay-er of tissue united, shown transversely and longitudinally.
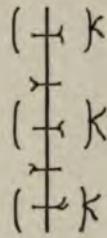
FIG. 1714.—Urethror-rhaphy. Deep and superficial tissues closed, shown trans-versely and longi-tudinally.
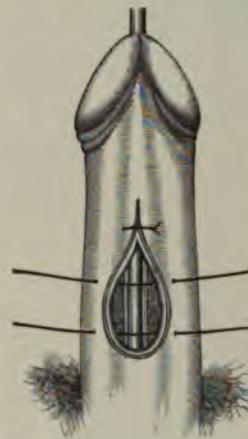
FIG. 1715.—Closing large ure-thral fistula. Oval freshen-ing.

surfaces together by sutures passed through leather supports at each side. Two or three rows of sutures can be used instead of this method of apposition.

Delpech dissected up a single flap, drew it across the fistula, and fastened it to a raw sur-face prepared on the opposite side. *Arlaud* made two transverse flaps, one in front and the other behind the fistula, about an inch and a half in width. The anterior one was dis-sected up toward the glans about three fourths of an inch, and the posterior one back over the scrotum, until it could be easily drawn forward so as to cover the fistula. The cutaneous surface of the anterior por-tion of the scrotal flap was freshened and the flap drawn forward so as to cover the fistula, and the anterior flap drawn backward over it and united by sutures.

Rigaud (Fig. 171
the method employe
lateral median f

FIG. 1716.—Closing large ure-thral fistula. Freshened bor-ders and lateral flaps.

at the peno-scrotal junction by
it of epispadias. A quadri-
ring, was taken from the

scrotum, turned forward over the fistula, and its raw surface covered by two flaps taken from the sides and drawn together so as to meet in the median line.

Dittel's Method (*by flap sliding*).—According to Dittel, when the fistula lies in the neighborhood of the scrotum, it is easy to draw the scrotal skin over it. But, should the posterior angle of the coapted surfaces be exposed to urinary infiltration, it would be better to employ a skin flap which has been liberated from the subcutaneous tissues.

The operation is performed as follows: A large metal sound is introduced, putting the urethra and fistula opening on the stretch. The scar tissue around the fistula is trimmed away, so that the resulting freshened surface has an oblong shape, its long diameter lying transversely to the long axis of the penis. An incision parallel with the posterior margin of the wound is now made through the scrotal skin, which is distant from the fistula one to one and a half inch, according to the size of the denuded area. The flap thus outlined is dissected up from the subcutaneous tissues, forming a transverse bridge of skin which is slid forward over the area to be covered. The anterior margin of the bridge is joined to the
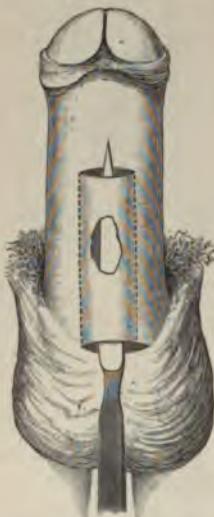
Fig. 1717.—Urethroplasty, Nélaton's method.

Fig. 1718.—Urethroplasty, Dieffenbach's method.
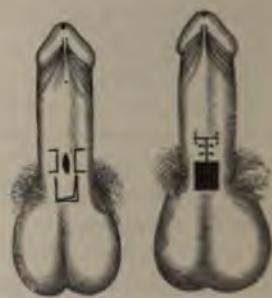
Fig. 1719.—Urethroplasty, Rigaud's method.

anterior margin of this area by means of button sutures. The posterior slit is left open, or is used in so far as to introduce a soft, thin catheter for the purpose of raising the hinder margin of the bridge and protecting the wound from urinary infiltration. After the flap has united anteriorly, the posterior slit is freshened up and its edges united in a manner similar to that already described.

Operation by Flap Transplantation.—In refreshening the edges of the fistula in this operation, a long oval shape is given to the denuded area. A flap, the size of which somewhat exceeds that of the area to be covered, is formed from the scrotal integument, its base situated either quite at the posterior end, or else near one side of the refreshed oval surface. In the former instance the flap is swung around on its pedicle, as is a flap from the skin of the forehead in rhinoplasty. In the latter, the flap is exposed to a mod-
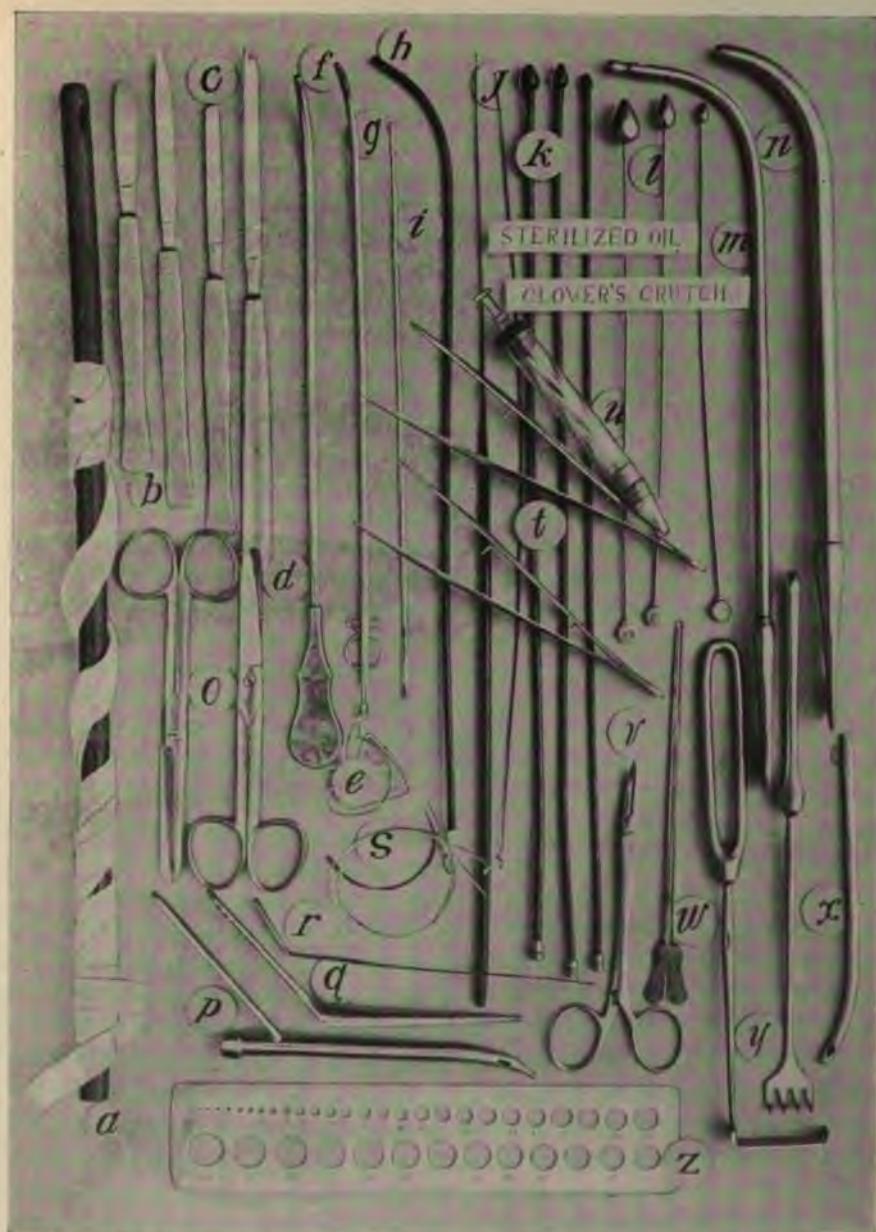
Fig. 1720.—Instruments employed in perineal section and conditions requiring it.

a. Perineal drainage tube with tapes. *b.* Bistouries, straight and blunt. *c.* Bistoury, blunt-pointed. *d.* Blizard's lithotomy knife. *e.* Traction loops. *f.* Tunneled staff. *g.* Tunneled catheter and stylet. *h.* Small gum catheter. *i.* Long silver probe. *j.* Banks's whalebone dilator and a whalebone guide. *k.* Flexible gum bulbous bougies, assorted sizes. *l.* Otis's metallic bulbous bougies, assorted sizes. *m.* Grooved staff. *n.* Steel sound. *o.* Scissors, short blunt-pointed, straight and curved. *p.* Brown's flushing director. *q.* Teale's gorget. *r.* Arnot's fine director. *s.* Large curved needle and silkworm gut. *t.* Thumb and mouse-tooth forceps. *u.* Glass penis syringe. *v.* Forcipressure. *w.* Grooved director. *x.* Female catheter. *y.* Blunt and hooked retractors. *z.* Scale for determining size of bougies and sounds. Wipers, ligatures, and gauze should be provided.

1479

erate tension. The flap is sewed in position by means of button sutures.
After union has taken place at its free extremity a secondary operation is
performed for closure of the opening at the base of the flap, and for the
proper treatment of the pedicle.

Urethrotomy.—*Poncet* exposes an incurable stricture through a median
incision in the usual manner, divides the urethra transversely at the proxi-
mal side of the constriction, slits the under surface of
the central stump for a short distance, and stitches it to
the lower angle of the cutaneous wound. The end of the
peripheral urethral stump is sutured, dropped into the
wound, which is then closed and stitched down to the
perineal opening.

Perineal Urethroplasty.—Perineal urethroplasty has
been practiced in the repair of the gap in the urethra
following urethrectomy for extreme stricture and for
partial or complete rupture of the urethra. *Wölfler* re-
moved the cicatricial area of a strictured urethra, and
covered the granulating surface with mucous membrane
taken from a prolapsed uterus, the same as Thiersch's
skin grafts are applied. The tissue was kept in place
with lubricated iodoform gauze. Several successful re-
sults of this nature are reported. *Keyes* secured a par-
tial success by grafting the inner layer of the prepuce.
In not a few instances, when due to rupture (page 1485)
or excision of a stricture, the urethra has been repaired
by the union of the divided ends over a catheter with
catgut or silk sutures (Figs. 1728 and 1729). *Weir*
reports two such cases as successful with silk sutures and
suprapubic drainage in urethral rupture. *Robson* re-
ports a success in a case of urethrectomy for stricture by
continuous catgut sewing of the divided extremities over
a catheter.

The General Remarks.—After these operations the
urine should be kept bland by a free use of diluents and
other corrective remedies. The parts should be kept
thoroughly cleansed and free from misdirected handling.
Incurving is due in part to shortening of the capsule of
the corpora cavernosa and perhaps of the fibrous septum,
and considerable time—five or six months—may pass be-
fore the tendency to return of this deformity disappears.

Fig. 1721.—Syme's
grooved staff.

The muco-cutaneous ridge corresponding to the absent
urethra must be divided transversely in a subcutaneous or open manner.
Duplay commends the latter, advising that they be carried to some depth
and the borders united longitudinally, thus overcoming the curvature.

External perineal urethrotomy (*Gouley*), sometimes called *perineal
section*, is employed in the treatment of intractable strictures, especially
when accompanied by a urethral fistula located in the perinæum and for
rupture of the urethra. External perineal urethrotomy may be performed

either *with* or *without a guide* and under thorough asepsis. The former is not a difficult operation, while the latter is frequently an extremely perplex-
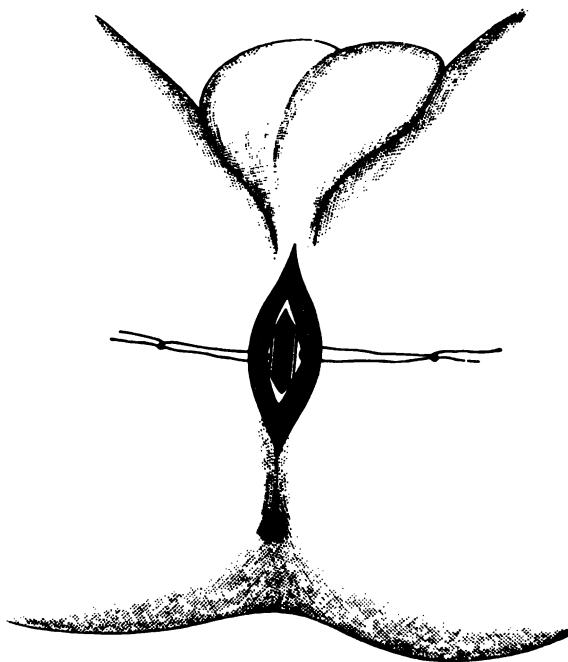
FIG. 1722.—The operation of external perineal urethrotomy. Grooved staff seen between separated borders of incisions.

ing one. Syme's grooved staff (Fig. 1721) is objectionable, in that its point may get into a false passage and the stricture be missed. Moreover, its introduction through the stricture is more difficult than that of the whalebone guide, and is attended by greater danger to the soft parts. If the ordinary small-sized grooved staff employed in lithotomy can be introduced, nothing better than this need be desired.

The Operation with a Guide (for stricture).—Evacuate the bowel shave and cleanse the perinæum, administer an anæsthetic, disinfect and fill the urethra with aseptic olive oil, locate the seat of the stricture, and

FIG. 1723.—Banks's dilating ᵃ

introduce a whalebone guide into ᵗ   ᵣe de-
scribed (page 1307); over this pᵃ   'ᵗff

down to and through the stricture (Fig. 1485), if it can be done readily; if not, allow its beak to rest against the obstruction, the instrument being carefully supported by an assistant, who at the same time raises and holds the scrotum. The patient is now placed in a lithotomy position, and the limbs supported by an assistant upon either side. The surgeon, sitting upon a low stool facing the perinæum of the patient, introduces the left index finger into the rectum to ascertain the condition of the membranous and prostatic portions of the canal. A free incision, from an inch to an inch and a half long, is then made in the median line of the perinæum, extending from the base of the scrotum to within half an inch of the anus, through the integument and fascia. The grooved instrument is carefully located by the finger, and the urethra brought into view by repeated cuts in the same line. The nail of the index finger assures the surgeon of the location of the groove, and the urethra is divided longitudinally upon it. Two silk traction loops are now passed, one through each border of the divided urethra, and are given in charge of assistants, who are instructed to carefully draw the lips of the wound apart (Fig. 1722). This important step exposes the mucous wall of the urethra completely, enabling the operator to follow its course by carefully observing the continuity of its structures. The staff is now withdrawn sufficiently to expose the black whalebone guide, then the beaked bistoury (Fig. 1724) is introduced in its course, and the stricture, together with

FIG. 1724.—Gouley's beaked bistoury.

FIG. 1725.—Gouley's grooved director (c) and tenaculum (e).

FIG. 1726.—Mercier's invaginated catheter. a. Retaining catheter. b, b. Invaginated catheter.

about half an inch of the canal immediately behind it, is divided in the median line.

The entrance of a grooved director or a small gum catheter through the opening into the bladder, followed by the flow of urine, assures the surgeon

that the proper channel is located; or, after the division of the stricture, the tunneled catheter (Fig. 1485) may be passed along the whalebone guide into the bladder, and the stylet withdrawn, when the diagnostic urinary stream will appear. The instruments are now withdrawn from the urethra, and the ordinary sound of suitable size is introduced through the urethra into the neck of the bladder, to determine the complete freedom of the passage.

The Remarks.—The passage of bulbous bougies (Figs. 1720 and 1733), with the object of determining the number, location, size, and resiliency of the strictures (page 1488), should be practiced, thus establishing the need of a more active operative treatment than that by the use of sounds. The whalebone filiform bougies of Banks (Figs. 1723 and 1733) are so shaped above as to readily overcome a stricture through which the advancing end has already passed far enough for the purpose. However, great care should be exercised in their use, or harmful results will quite surely follow. The beaked bistoury of Gouley (Fig. 1724), the grooved director (Fig. 1725, c), and small sharp tenaculum (Fig. 1725, e), are of special aid in this operation. Sometimes a small invaginated catheter of suitable dimensions (Fig. 1726) will find a way along devious channels that can not otherwise be traveled. This agent is of much greater utility in connection with retention of urine from prostatic enlargement (page 1308) than when
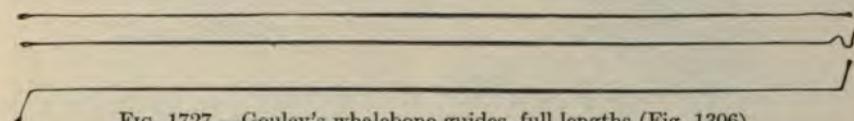
FIG. 1727.—Gouley's whalebone guides, full lengths (Fig. 1306).

associated with perplexing false passages. It is evident at once that the invaginated catheter will, after its escape, point a different course to that of the external one, and therefore gain prompter admission to the bladder.

The Operation without a Guide.—After all efforts to introduce a whalebone guide (page 1307) into the bladder have failed, pass the tunneled catheter staff (Figs. 1482, k, and 1487) over a whalebone guide along the urethra as far as it will go without using violence; then place the staff and guide in charge of an assistant as before. Make an incision of the usual length directly in the median line down to and through the urethra into the groove at the end of the staff; pass the silken loops through the borders of the incised urethra as before (Fig. 1722); check all hæmorhage, withdraw the staff slightly, and examine to see if it be located in the urethral tube. The lips of the urethral incision are now drawn well apart, and the operator, whose patience, care, and knowledge must now be well tested, endeavors to introduce a whalebone guide, ▨ fine probe, or a small grooved director (Fig. 1725. c) through the stri▨　into the bladder by way of the perineal incision. ▨he remainder of the operation is simple, and▨　▨ricture with the beaked (Fig. 1724) or a ▨　▨nward as before; usually, how-

ever, no anterior opening can be found, or one may be detected which leads away from the median line, showing the existence of a false passage.

In either case the plan of the operator must be the same. Keep in the median line. If, after a patient search, no direct orifice be found, it is often possible to detect it by making moderate pressure above the pubes on the bladder, which will frequently cause a few drops of urine to escape from the obscure opening in the perineal cut, into which a whalebone guide or a fine director can be inserted, and usually passed into the bladder. Hot-water injection into the wound will sometimes reveal the urethra by emphasizing its paler color. *Gibson* determines the location of the deep urethra, after the perineal wound is made, by introducing the finger into the bottom of the wound and then making downward and backward traction on the apex of the prostate by means of a strong tenaculum hooked into it through the anterior wall of the rectum, exposed for the purpose by means of a speculum. With each pull upon the tenaculum corresponding tension of the urethra is noted by the tip of the finger in the wound. If nothing is accomplished by either of these, then the surgeon feels for the opening in the triangular ligament (Fig. 1584), through which the urethra normally passes, and cuts toward, and even through it if the urethra can not be found before. As he cuts he repeatedly seeks for the orifice, and closely examines for a continuity of the fibrous mass in the line of his incision with

FIG. 1728.—Incomplete rupture of urethra with catheter in the canal preparatory to sewing.

FIG. 1729.—Incomplete rupture of urethra being sutured over catheter.

the tissues composing the walls of the urethra. In the obscure division of the amalgamated perineal tissues the surgeon is also guided by the established relations of the normal urethra to the arch and rami of the pubes, to the tuberosities and rami of the ischium (Fig. 1583 and page 1401), and, still more important, the relations to the rectum. The careful cutting and searching are continued until an opening is found which leads into the bladder. The tissue barring the passage is cut, and a small gum catheter is passed along the probe or director into the organ. This act is followed by the welcome flow of urine. The catheter is then withdrawn, the canal dilated gently, and all constricting bands at the roof and floor of the urethra are severed. A steel sound the size of the canal is then introduced into the bladder through the urethra until its uninterrupted entrance is assured. The size of the meatus is increased, and all obstinate strictures in front of the perineal opening divided by internal urethrotomy. Examine the bladder for stone, and if found remove it; stop all bleeding.

In rupture of the urethra, occasionally a catheter or staff may be passed quite readily into the bladder. But in instances of complete rupture from bruising of the perinæum, or incomplete rupture complicated with narrow stricture, this measure can not be accomplished at once, if at all, especially

in a case of the former condition. In rupture from bruising, a free incision into the perinæum is made in the median line down upon the convexity of a grooved staff (page 1411), if introduced into the bladder; if not, upon the advanced end, thus exposing the seat of the injury and permitting of the elimination of the blood clots and extravasated urine. The bleeding is then arrested and the injury of the urethra found. If the rupture be in-

complete the urethra is treated as in external perineal urethrotomy for other causes (page 1480 *et seq.*), or repaired in a manner indicated (Figs. 1728 and 1729). If the rupture is complete no difficulty attends the recognition of the distal extremity of the canal, as the instrument is seen passing through it. The finding of the proximal end, however, is often tedious and difficult, requiring the same care and scrutiny that characterizes its discovery in perineal urethrotomy without a guide (page 1483). After securing the proximal end repair can be effected by sewing over a catheter introduced for the purpose (Figs. 1728, 1729, and 1730). When the proximal end can not be found the blood and urine usually will readily escape, and the danger of further extravasation will be prevented. However, if plastic repair of the urethra be contemplated, or retention of urine be likely to happen, it will be necessary to open the bladder above the pubis (Fig. 1491), and practice *retrograde catheterism* to prevent the latter; also to accomplish the former purpose (Fig. 1731).

FIG. 1730.—Complete rupture of urethra, proximal end found. Introduction of catheter preparatory to sewing. *a.* Distal end of rupture. *b.* Proximal end of rupture held open by forceps for introduction of catheter (*c*). *d.* Catheter introduced into urethra.

The Precautions.—Carefully avoid injury of the structures by persistent efforts in passing a catheter or staff. Operate promptly to prevent needless extravasation of urine and consequent suppuration and fistulæ. Extravasation between the layers of the triangular ligament (Figs. 1583 and 1584) and beneath the superficial perineal fascia do not cause tumefaction until after rupture of the fascial restraints and the consequent extended infiltration (page 1401). It should not be overlooked that a catheter, while plugged with blood, when introduced into the bladder through the proximal end of a ruptured urethra will not permit urine   ape; otherwise it may be thought that the instrum·   ·ever, if the eye of the

instrument be cleared by a stream of water, and other facts relating to catheterism of the bladder already noted (page 1303) be heeded, this perplexity will be speedily removed.

The Results.—In 29 reported cases of rupture of the urethra treated by immediate suture, all are announced as successful. These results are astonishing and commend repetition.

The After-treatment.—Place the patient in bed with hot fomentations to the abdomen; elevate the scrotum to prevent infiltration; administer ano-
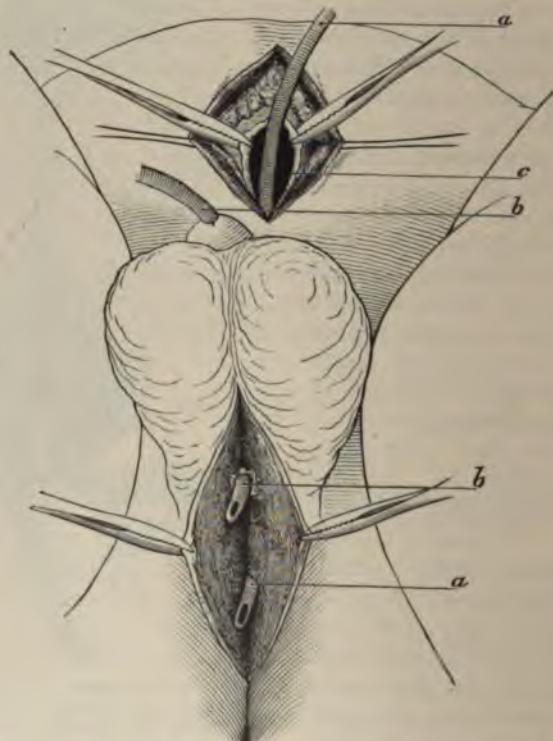
FIG. 1731.—Complete rupture of urethra, proximal end not found, retrograde catheterism. Introduction of catheter preparatory to sewing, a retrograde introduction practiced only when the proximal ruptured end can not be found for the purpose of sewing. Suprapubic opening utilized for drainage. *a, a.* Extremity of intravesical catheter. *b, b.* Extremities of catheter in penis. *c.* Wall of bladder.

dynes and demulcents, and keep the patient quiet. The major portion of the perineal wound may be closed by sutures carried deeply, leaving, however, sufficient room for the introduction of a large, flexible catheter through the neck of the bladder, which is fastened in place by means of tapes (Fig. 1720). It is allowed to remain in position for four or five days, unless its presence causes some degree of vesical irritation. The wound should be dressed antiseptically. The catheter should be kept clean by regular antiseptic injections and not allowed to extend too far into the bladder. After

removal of the instrument, regular catheterization at short intervals should be practiced for a time. The use of boric acid, salol, or urotropin for urinary sterilization is important. Suitable-sized sounds should be passed every two or three days for a considerable time at a later period, in order to gain

FIG. 1732.—Civiale's *bistouri caché*.

a urethra of the normal caliber and thus secure closure of the perineal opening.

The Results.—In 8,000 cases of external urethrotomy performed some years ago, a little over 5 per cent died. Stricter aseptic measures have lessened this rate.

Internal Urethrotomy.—Internal urethrotomy consists in the division of strictures by cutting instruments introduced within the urethra. The division may be made from before backward or from behind forward, depending on the extent of the stricture and the inclination of the surgeon. Ordinarily they are cut from behind forward. The roof or the floor of the urethra may be divided in either instance, the division of the former being regarded the safer and better procedure. Thorough asepsis should be practiced in all cases.

Internal urethrotomy should be limited to strictures of the penile portion. The subpubic strictures and those of the membranous portion should be divided through the perinæum. *The number, size, location, and extent* of the obstructions should be determined before their division is attempted.

If it be the intention of the operator to distend the canal to its fullest capacity, and if the meatus be undersized, the latter should be enlarged before the stricture is divided. Enlargement can be easily accomplished by means of the *bistouri caché* of Civiale (Fig. 1732). After properly distending the meatus the bistoury is introduced with the cutting surface down-
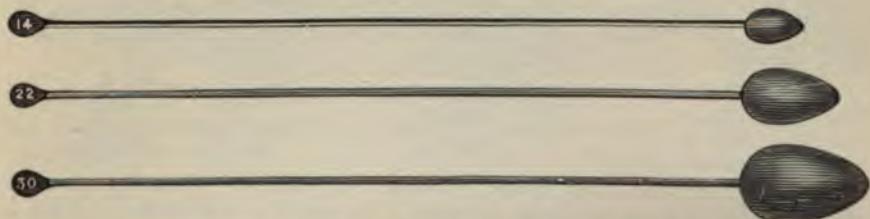
FIG. 1733.—Otis's bougies à *boule* (metallic).

ward, and quickly withdrawn. The ordinary pr?   ?istoury, or a
straight-edged one, with the end guarded, wil   ?per-
fectly. The lips of the cut will unite unless t
tic lint or cotton, or by the occasional intr?

The location, number, and size of strictures can be determined by the intro
duction of metallic (Fig. 1733) or gum-elastic (Fig. 1720) bulbous bougies
of assorted sizes. One of large size that will slip through the meatus is
selected, oiled, and passed down the canal until arrested. The distance in
the canal is noted on the handle. It is then withdrawn,
and the size of the bulb measured by the familiar scale.
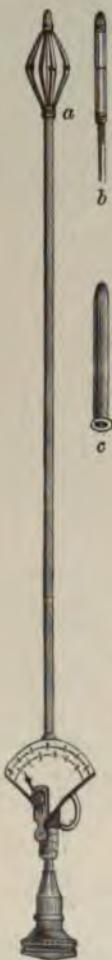
The surgeon next ascertains the size of the bougie that
will pass the obstruction, and so on, recording the loca-
tion and size of each obstruction in its turn until the
bladder is entered. The urethrometer of Otis (Fig.
1734) is constructed on a principle calculated to give
practically accurate measurements. The unexpanded
blades of the extremity of the instrument, b, are covered
by a small, thin rubber cap, c: the instrument is oiled and
carried, closed, through the last obstruction, if possible,
when the extremity is expanded by a screw at the outer
end until it fills the urethra, the capacity of which is
noted upon the dial; it is slowly withdrawn while the ex-
panding extremity is regulated to accommodate the varied
dimensions of the canal, the caliber of which, in the dif-
ferent locations, should always be noted. By this simple
though ingenious method the surgeon is enabled to locate
quite correctly the seat and caliber of the obstacles he is
to treat.

Urethrotomes, like other instruments designed for
special purposes, vary in many important particulars.
These, however, of greatest practical utility were devised
by Otis and by Peet (Figs. 1735, 1736, and 1737). Each
bears upon its handle a scale which enables the operator
to ascertain not only the size but the distensibility of an
obstruction. Either of these instruments when taken in
connection with the urethrometer, enables the surgeon to
divide the strictured parts until the scale on the dial or
handle of the cutting instrument indicates that the stric-
tured portions of the urethra correspond in size to the
dimensions of the normal portions, as already indicated
by the dial of the urethrometer.

The Operation.—After cleansing the urethra a gen-
eral anæsthetic or cocain solution is employed, and the
patient is placed upon the back. Then a well-oiled asep-
tic instrument is introduced, and the extremity conceal-
ing the blade is carried beyond the obstruction, which is
dilated by turning or depressing the screw at the end

Fig. 1734.—Otis's
urethrometer. *a.*
Blades expand-
ed. *b.* Blades
unexpanded. *c.*
Rubber cap.

until the strictured tissues are made tense, when the knife is withdrawn
sufficiently to divide the stricture freely. The action of the instrument is
then reversed and the knife pushed back into its hiding place, and the
instrument again dilated to note the effect of the incision upon the caliber
of the stricture. If the caliber still be below the standard, as indicated

by the urethrometer, incision is again made. In this manner each constriction can be divided and the urethral tube made of a uniform diameter throughout. If two or more strictures have a common, or an almost common, diameter, they can be cut simultaneously by drawing the knife along the course of the shaft. There is little danger of cutting the healthy
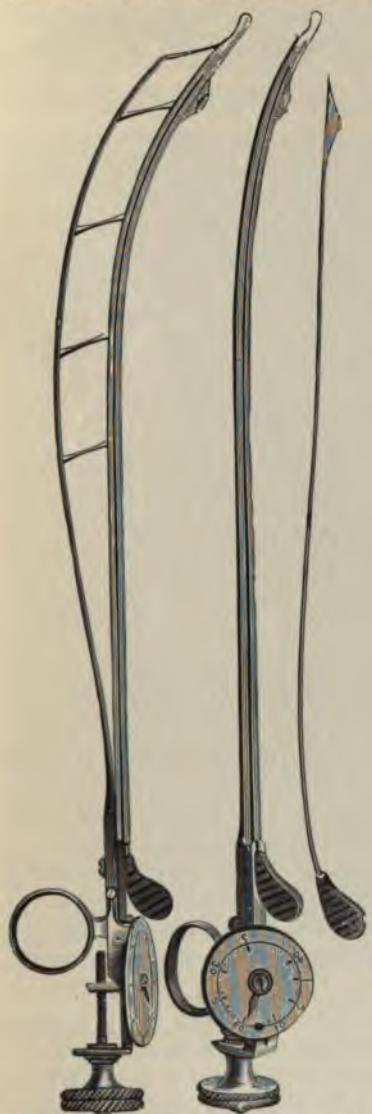
FIG. 1735.—Otis's curved urethrotome, expanded and closed.

FIG. 1736.—Otis's straight urethrotome, expanded.

FIG. 1737.—Peet's urethrotome, expanded.

mucous membrane so long as the dial on the urethrotome indicates a smaller dimension than that of the normal urethra, as shown by the urethrometer.

The Complications.—If severe hæmorr can be introduced, and the penis bandage

97

means of a stream of iced water conducted through a double-barreled catheter. It is sometimes necessary to make pressure on the perinæum, in conjunction with other expedients. The necessity for this is extremely rare. Unless aseptic care be exercised in the manipulations directed to the arrest of hæmorrhage, septic poisoning may result.

The After-treatment.—Following urethrotomy the patient must be kept quiet in bed for three or four days, with a light diet and open bowels; demulcent and alkaline drinks are often advisable. A sound may be passed every third day until the wound is healed.

The Results.—Few patients perish as the direct result of internal urethrotomy, and, when carefully done upon proper cases, an unfavorable result need not be anticipated. If, however, severe bleeding happen, requiring urethral manipulation to arrest it, septic changes may be caused and an unfavorable outcome result. The inclination to perform internal urethrotomy has abated much indeed in the last few years, and wisely, too, as it appears to the writer. The paraphernalia for arrest of hæmorrhage arising from too free or incautious division of strictures is so suggestive of ominous outcome in many cases as to inspire the caution in division that has been followed by more conservative action and consequently a lessened rate of disaster from complicating causes.

Fig. 1738.—Tapping urethra.

The Tapping of the Urethra (Cock). — Tapping the urethra in a distended bladder from impassable stricture is a feasible operation under urgent circumstances.

The Technique.—The patient is placed in the lithotomy position, and the left index finger, protected with a rubber finger cap, introduced into the rectum, and its tip pressed against the apex of the prostate (Fig. 1738). A double-edged knife is then carefully thrust into the perinæum in the median line, the point being directed to the tip of the finger, and caused to open the urethra in front of the prostate, behind the stricture, by a slight lateral motion. As the knife is withdrawn, the dimensions of the wound may be increased anteriorly. A grooved director is then carried into the bladder through the opening, and a catheter passed upon it to relieve the distended viscus. The opening may be made through the anterior wall of the rectum when objections exist to the perineal puncture, which, however, is rarely the case. The knife should not be withdrawn until the director is passed into the bladder, otherwise the line of incision may be lost. Suprapubic aspiration should be employed in place of rectal and urethral t when possible.

MISCELLANEOUS OPERATIONS.

Psoas Abscess.—Psoas abscess can be opened directly from behind with comparatively little danger, and with the attainment of good drainage. Although *Israel* operated first, to *Treves* more than to any one else belongs

FIG. 1739.—Instruments employed for operation on psoas abscess.

a. Large and small scalpels. *b.* Forcipressure. *c.* Short blunt-pointed, straight and curved scissors. *d.* Dressing and mouse-tooth forceps. *e.* Blunt and hooked retractors. *f.* Sponge-holder with sponge. *g.* Barker's flushing gauge. *h.* Long curved needle. *i.* Grooved director. *j.* Perforated drainage tube. *k.* Long silver probe. *l.* Scoop. *m.* Catgut ligatures. Silkworm-gut sutures, wipers, small sponges, bandages, and an aspirating needle, etc., are required.

the credit of the establishment of the simplicity of the operation from an anatomical standpoint.

The Anatomical Points.—The width of the erector spinæ muscle (about 'd the arrangement of the lumbar fascia with reference to 'he quadratus lumborum, and the psoas magnus muscles, 'he vertebræ, should be carefully noted before opera-

tion (Figs. 1195 and 1196). The length and shape of the transverse processes of the lumbar vertebræ and their connections should be recalled also. The detail of the origin of the psoas magnus, the course of the lumbar vessels, the relation of important vessels and nerves to the anterior surfaces of the bodies of the vertebræ, are of much importance in suggesting the limitation of manipulative measures.

The Operation (Treves).—Make a vertical incision along the outer border of the erector spinæ, with the center midway between the iliac crest and the last rib (Figs. 1194, 1195, and 1196), two inches and a half in length down upon the lumbar fascia; divide the fascia and expose the fibers of the erector spinæ the entire length of the incision; separate the outer border of the muscle from the sheath, and draw the entire muscle toward the median line with retractors, thus exposing the anterior layer of the sheath—i. e., the middle layer of the lumbar fascia; divide the anterior layer of the sheath vertically as near to its connection with the tips of the transverse processes as convenient, thereby exposing the quadratus lumborum muscle (Fig. 1194); sever the muscular fibers close to the end of a transverse process, and enlarge the incision cautiously to the full extent of the wound; divide the anterior layer of the lumbar fascia, and expose the outer border of the psoas magnus muscle; sever some of the tendinous fibers of the psoas from the transverse process, close to the bone anteriorly; introduce the finger beneath the muscle and carry it gently along the surface of the process to the anterior aspect of the body of the vertebra, thus entering the abscess cavity; continue the exploration with the finger until the extent and condition of the vertebral structures are determined as far as practicable. Irrigate the abscess cavity with a solution of bichloride of mercury (1 to 5,000), causing the fluid to come in contact with every aspect of the wall by manipulation and change of the position of the patient, and repeat the emptying and filling of the abscess cavity; remove the pyogenic lining by scraping with the fingers also isolated collections of carious matter; instead of the fingers, small, fine sponges can be employed, on a sponge holder, and introduced into every part of the cavity, which is scoured in turn by vigorous to-and-fro and rotatory movements of the sponge. The flushings and sponging of the cavity are repeated until no gross evidences of disease any longer appear. The cavity of the abscess is then wiped dry with sponges, and the wounds are closed by silkworm-gut sutures carried deep enough to include the muscular and tendinous structures. An aseptic dressing, secured in place by a body bandage, completes the operation.

The Precautions.—Care should be exercised in cleansing the abscess cavity not to encroach on the thin walls, and thus injure the abdominal vessels (Fig. 1036). A close adherence to the spinous processes in reaching the abscess insures against danger of injury to the lumbar arteries. If the incision be directed too far outward, the peritoneal cavity may be opened.

The Remarks.—If the patient be thin, the seat of disease is easily reached; if very stout, much difficulty in reaching it is experienced, and it may be impossible to do so in some cases. The side selected depends on convenience of operating and the seat of the preponderance of the disease. The right side is somewhat more convenient, but this is not of sufficient

FIG. 1740.—Instruments employed in repair of fractures of patella and long bones.

a. Scalpels, large and small. *b.* Forcipressure. *c.* Forceps, thumb and mouse-tooth. *d.* Rugine. *e.* Volkmann's scoop. *f.* Brainard's bone drill. *g.* Hamilton's bone drill. *h.* Fluhrer's crochet drill. *i.* Silver-wire suture. *j, k.* Fluhrer's fork and grooved retractor. *l.* Chisel. *m.* Toothless iron-jaw forceps. *n.* Periosteotome. *o.* Phelps's instrument for holding fragments of patella. *p.* Saw. *q.* Retractors, hooked and blunt. *r.* Scissors, straight and curved, blunt-pointed. *s.* Rongeur. *t.* Bone-cutting forceps. *u.* Silver wire. *v.* Curved needle. *w.* Ivory pegs. *x.* Spatula. Silkworm gut, catgut, silk, sponges and wipers, and fine curved needles are required.

moment to lead one to disregard the importance of attacking the disease at the seat of the greatest development. In the presence of marked kyphosis, the space between the crest of the ilium and the last rib may be reduced and even almost abolished. The flushing gouge of Barker already described (Fig. 370, *d*, page 357) can be used to cleanse the abscess cavity of the products of disease. Hot water, at a temperature of 110° or 112° F.,
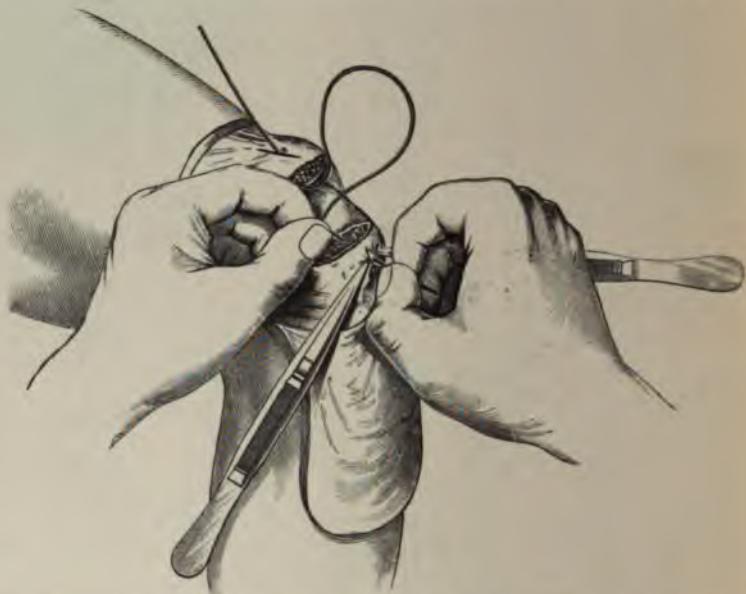
Fig. 1741.—The operation of suture of patella, Cheyne's oval incision. Introduction of wire through lower fragment ; leg flexed.

can be used in washing. The introduction into the cavity of the abscess of the iodoform emulsion, followed by closure of the wound, and antiseptic dressing retained in place undisturbed for a week or ten days, is often followed by prompt healing and cure. Incision at the posterior border of the sterno-mastoid, so as to reach the brachial plexus, which, as a guide, leads to diseased bone in the cervical region, has been practiced.

The After-treatment.—The after-treatment is that directed to the cure of Pott's disease, and raises the question of absolute rest in bed for an indefinite time, *versus* the use of artificial support with out-of-door advantages, a question which can not be discussed here. If the wound does not heal at once, or the line of union breaks down, the washing-out and scrubbing process can be repeated.

The Results.—While success has attended the operation in some cases, the outcome, as a rule, is unfavorable.

Suture of the Patella for Fracture.—Suture of the patella with wire is now generally accepted as a justifiable measure in selected cases. In our opinion, the operation should not be performed except for other reasons than that of the existence of a simple fracture of the bone, because

believe that it is good surgery to expose a patient to the contingencies of suppuration, amputation, ankylosis, and even death, for the better rectification of an injury which, at its worst, has no tendency to terminate fatally, and almost invariably results in a serviceable limb when treated by the ordinary methods. It is as impossible as it would be unwise to indicate definitely the cases for wiring, as each case should be considered on its own merits. When the end to be gained will justify the attempt, the operation need not be deferred.

Thorough aseptic measures should be employed in connection with every essential detail of the procedure.

Three different incisions are practiced in this operation: the vertical, the transverse, and the oval. *The vertical incision* is made in the median line of the bone down upon the fracture, and is of sufficient length to permit the ready exposure of the line of fracture and afford room to cleanse the joint. In this instance, one or two wires—now usually one—is employed, and is placed at the median line in front. The writer has practiced this form of incision frequently, and with entire satisfaction. It places the scar vertically, and obviates the danger of stretching or rupture when overflexion happens. The incision does not afford as favorable an opportunity to trim
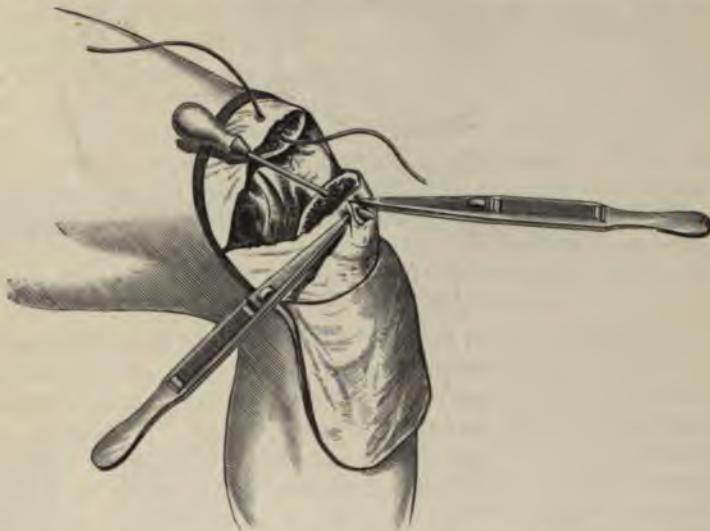
FIG. 1742.—The operation of suture of patella, Cheyne's oval incision. Drilling lower fragment; forceps drawing aside divided fibrous tissues; leg flexed.

and repair the lateral laceration of the capsule as transverse incision, and directly invades the prepatellar bursa (Figs. 433 and 1750).

The transverse incision is made directly across the joint, between the inner and outer aspects, at or close to the line of fracture. This form of ˥ permits of extended examination of the joint cavity and the repair ˥ceration of the capsule. However, the cicatrix is exposed to the rect and to flexion violence, and in many instances refracture

has been complicated with laceration of the cicatrix. This incision is almost certain to open the prepatellar bursa (Figs. 433 and 1749).

The oval incision, with the convexity downward or upward (Cheyne), is a good form of incision. It affords the same opportunities as the transverse one, but with less danger of subsequent complications. It extends between the outer and inner aspects of the knee and considerably below or above, as the case may be, the line of fracture in front. *Lucas-Championnière* is an earnest advocate of the flap method. It should not involve the prepatellar bursa.

The Operation.—Place the patient on the back with the limb extended and the heel raised; expose the fracture freely, and, if need be, the joint cavity through the selected incision; remove blood clots from the broken aspect of the fragments with a bone scoop, and intervening fibrous and other tissue with scissors, so that the fractured surfaces can be brought into proper apposition; remove from the joint cavity, by means of sponges
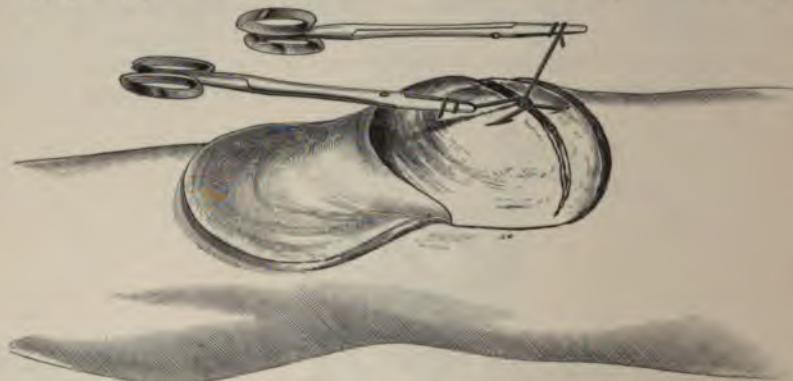
Fig. 1743.—The operation of suture of patella, Cheyne's oval incision. Bringing fragments together; leg extended.

and hot saline solution flushing, blood clots and foreign bodies, giving especial attention to the upper synovial pouch (Fig. 433, *a*), and to the recognized anatomical recesses of the joint; if drainage is to be introduced, carry silkworm-gut drainage into the joint through a perforation of the tissues made at the lower part of the external condyle from within outward by means of a long, sharp-pointed scissors curved on the flat; flex the leg and bore each fragment (Fig. 1741) deeply or superficially at one or two situations for large or small wire, as circumstances may demand (Fig. 1742); cleanse the joint cavity again, and bring the fractured borders in contact with each other by twisting the ends of each wire together along the line of a corresponding incision made down to the bone by a sharp-pointed knife, as firmly as is consistent with the security of the union (Fig. 1743); cut off the twisted ends a quarter of an inch or so above the bone, and flatten them against the bone (Figs. 1744 and 1770), for obvious reasons; trim the torn borders of the capsule, if desirable, and close the gap with an interrupted or continuous catgut or kangaroo-tendon suture; unite the divided borders of the patellar fibrous tissue with fine catgut, thus shutting off the more

completely from the external wound the joint cavity; close the external wound with interrupted silkworm-gut sutures carried deeply; dress the wound, and confine the joint immovably in an extended position until repair of the soft parts has taken place.

The After-treatment.—The after-treatment is like that of similar wounds at other parts of the body. When the healing of the soft parts is completed the limb may be incased in a fenestrated plaster-of-Paris splint, and thus the patient may be around on crutches until bony repair is established. Usually patients are up and about with the joint controlled by a plaster-of-Paris casement or only by a posterior support at the end of the third week. *Phelps* begins early to move the

Fig. 1744.—The operation of suture of patella for comminuted fracture.

patella, thus fitting it for use at a timely period. Massage is an essential element of after-treatment.

The Precautions.—Thorough asepsis should be had to forestall the possibility of suppuration of the joint cavity. Compound fractures of the patella should be wired at once, simple ones, as a rule, at a later period—eight or ten days after the accident (Phelps). It is advised by some, and is justifiable under unfavorable environment, to employ the douche during the operation. In case suppuration occurs the pus should be liberated at once, the joint freely washed with a bichloride solution, rubber drainage tubes introduced, and continuous irrigation with a warm bichloride solution (1 to 10,000) applied until the suppuration ceases and repair begins. If pus be present in the superior pouch (Fig. 433, *a*) it should be drained—and better above—to prevent purulent infiltration of the tissues of the thigh. Too vigorous or too early passive motion may cause refracture attended even with laceration of a transverse scar. Observe, in wiping the joint with sponge or gauze (small pads), that fragments of the former and threads from the latter do not remain behind to cause inflammation; periarticular suppuration

Fig. 1745.—Wire introduced.

may happen without involvement of the joint. If both periarticular and articular drainage be provided, the presence of pus in either place can be easily and readily detected, and evacuated at the earliest moment without the danger of speculative delay. The fragments in old fractures are apt to be porous and friable and easily torn through by the wire. Drainage should be employed or not, according to the surgeon's judgment of the individual case. He should strive to do that which gives to the patient the greatest security, rather than that which, while emphasizing his confidence and skill, may unnecessarily lessen the patient's security—the precept being, not what one can, but what one ought to do.

The Remarks.—In the writer's judgment the articular and periarticular spaces should each be drained independently with a thread or two of silk-worm gut in all instances of uncertainty. The measure does no harm and may forestall grave disaster. The trimming and repairing of the lacerated capsule does not seem necessary, as is shown by the uniformly good results —so far as the capsule is concerned—in the non-operative and subcutaneous methods of treatment (Figs. 1749 and 1752). And it is not improbable that the resulting shortening of the capsule from repair adds to the difficulty of the proper attainment of post-operative movement, to say nothing of the greater exposure of the joint to infection during the repair. Disconnected fragments of bone liable to necrose should be removed. When the bone is broken into three or more fragments, a sufficient number of sutures should be employed to secure suitable apposition of the pieces (Fig. 1744). In the instance of old fracture with irreducible separation, the quadriceps extensor tissues can be lengthened by making a V-shaped or oblique incision (page 1504) through them sufficiently to permit bony apposition. The wire should not be carried through the under surface of the patella (Fig. 1745). When an upper or lower fragment is very small, and when the bone is com-minuted, *Lejars* surrounds and holds in place the fragments by means of silver wire passed through the median line of the quadriceps and patellar tendons and close to the borders of the fragments, so as to confine them in proper place when the ligature is tightened. *Ceci* treats fractures of the patella in a similar manner with silk ligature (page 1502). The practice of exposing the fragments by means of a vertical or transverse incision, remov-ing the blood clots and uniting the fragments with kangaroo-tendon, silk, or catgut sutures passed through the margins of the fibrous tissue lying on the patella, the same as in fracture of the olecranon process (Fig. 1760), is favorably considered in those cases with but little tendency to separation of fragments or the occurrence of hæmorrhage. The bony borders are not brought as closely in contact by this plan as by the use of wire. The facts that blood clots in a joint are thought sometimes to form movable bodies there and are known to be admirable culture media for germs in infected cases, emphasize the wisdom of their removal. At the end of four or five weeks all restraint is removed, and passive motion of the patella from side to side and flexure of the limb are begun, and the patient is encouraged to use the joint, which usually of itself alone will restore the function in a few weeks. Douching, friction, and electricity are sometimes advantageous as after-treatment measures. An elastic kneecap may be worn for a time as a reminder of infirmity, if for no other reason.

The Results.—Prior to 1883 the patella had been wired 49 times, in which 2 of the patients died, 1 of pyæmia and 1 of exhaustion. Besides these, 6 cases resulted in suppuration and ankylosis. *Powers*, in his excel-lent study of "operative interference in recent simple fracture of the patella," * reported 711 cases, 474 of which were from personal communica-tions and 237 were gathered from the literature of the two years preceding the presentation of the paper. Of the first series, 4 died; of the second, 6.

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* Transactions of the American Surgical Association, 1898.

Of the 10, 3 died from sepsis and the remainder from other causes not related to operative technique. Surely the difference in the results of the extremes (1883 and 1898) exhibits a commendable record of the product of experience. Powers ascertained the opinions of 67 prominent surgeons, living here and abroad, regarding the advisability or non-advisability of operative interference in simple fracture of the patella. *Seventeen* were "opposed to the operation in any case"; *nine* "would operate in all cases in which no distinct contraindication exists and in which the surroundings are satisfactory"; *forty-one* "would operate in selected cases, those with wide diastasis, comminution, etc." More pointedly stated, 17 would not operate on any case for any reason; 9 would operate on every case except for special reasons; 41 would operate only on selected cases and for special reasons.
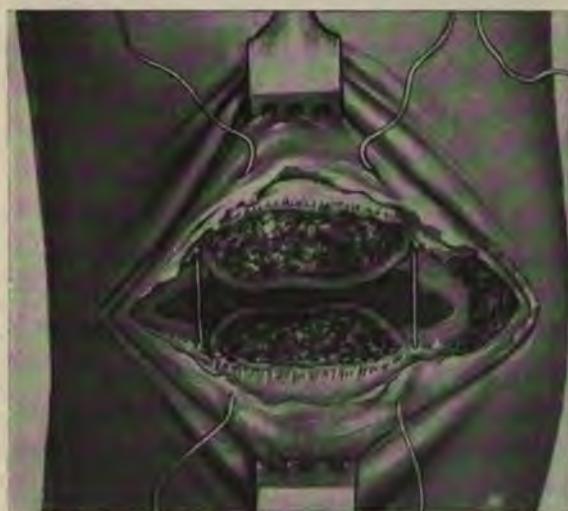
FIG. 1746.—Suture of patella, Blake's method. Showing the introduction of the sutures close to the sides of the fragments and in front of the synovia.

However, the perplexing frequency of superficial suppuration and rare occurrence of deep suppuration, of ankylosis, "poor results," etc., to say nothing of an occasional amputation and an infrequent death, still emphasizes the need of wide discrimination in the selection of and greater care in the treatment of cases by wiring, and also by other methods that involve the joint. No operative plan that is much employed is without the history of an unfortunate outcome.

Blake's Method.—After the usual preparation, connect the outer and inner aspects of the joint at points corresponding to the lines of articulation with a transverse convex incision passing about half an inch below the lower line of fracture; expose freely the complicating ' 'ions of the aponeurotic structure of the quadriceps extensor mus   t;
trim off from the fractured surfaces of the bo'   -
sue and remove the adherent clots; wash

with a stream of warm salt solution; arm a full-curved Hagedorn needle
with No. 4 chromicized catgut or with kangaroo tendon; pass the needle

FIG. 1747.—Suture of patella, Blake's method. Main sutures tied for the repair of the
lateral ruptures and of the tissues in front of the patella.

through the aponeurotic tissue about half an inch from the line of fracture
and as close to the fragment as possible, and bring it out on a line with the
tear just in front of the synovial membrane (Fig. 1746); introduce the needle
at the opposite side of the tear and pass it through the tissues, in reverse of
the order just completed (Fig. 1746); repeat the stitch in all respects at the
opposite side of the fractured bone; tie simultaneously the two sutures,
fixing such exact coaptation of the fragments as to prevent any lateral

FIG. 1748.—The opera-
tion of suture of
patella, Stimson's
method.

movement; repair the aponeurotic ruptures in front
and at the sides of the patella with fine catgut
stitches (Fig. 1747); close completely the remain-
ing wound with silkworm-gut sutures; apply the
usual form of aseptic dressings to the knee, and
surround the entire limb with a plaster-of-Paris
splint, which after two or three weeks is removed
daily for massage.

The Remarks.—Comminuted fractures of the
bone are amenable to this practice. It is better to
use instruments entirely than to employ protected
fingers, especially in the joint cavity. Blake oper-
ates as soon as convenient after the injury.

The results are in all respects satisfactory in
twenty-three cases thus treated.

This method of practice is promptly and easily
done, leaving behind in the wound no foreign body.

Stimson's Method of Treatment (Silk Suture)
(Fig. 1748).—In this method of treatment make a
median longitudinal incision extending well above and below the fragments,
down to the bone; remove the clots from the joint cavity and from the

fractured borders of the bone; lift up from between the fragments the fibro-periosteal fringe that may be there; pass a strong silk suture transversely through the ligamentum patellæ, close to the bone, thence in the opposite
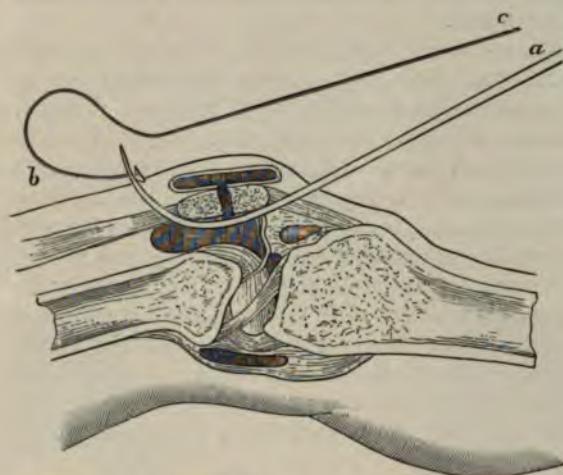
FIG. 1749.—The operation of ligature of patella, Barker's method. *a.* Needle passed beneath patella. *b, c.* Wire ligature in eye of needle.

direction transversely through the quadriceps tendon close to its insertion by means of a strong curved needle; hold the fragments in apposition and tighten and tie the suture; close the cutaneous wound without drainage, and confine the limb immovably until proper repair has taken place.
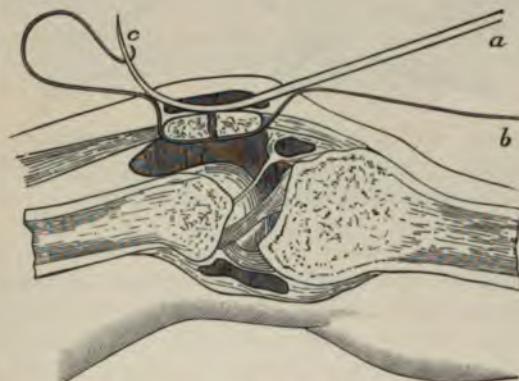
FIG. 1750.—The operation of ligature of patella, Barker's method. *a.* Needle passed in front of patella. *b, c.* Wire ligature in eye of needle.

The Results.—"This method seems to be as simple as any, and has proved to be efficient and safe in more than fifty personal cases " (Stimson). In 1896 Stimson reported 75 cases with   idents from the operation.

Barker's Method.—Barker's meth   of performance and

can be accomplished in a comparatively short time. *White* commends this method and has performed it fifteen times with entire success. He begins passive motion on the tenth day, gets the patient out of bed with a light splint on the limb at the end of the third week, and expects good use in from eight to ten weeks.

The Operation.—Under strict asepsis, with the patient on the back and the limb extended, steady the lower fragment with the thumb and finger; thrust a narrow-bladed knife with the edge upward, through the ligamentum patellæ at the point of insertion into the lower fragment, into the joint; carry through the wound thus made a pedicle needle (Fig. 1749), passing it upward beneath the fragments through the insertion of the quadriceps at the base of the upper fragment sufficiently to elevate the overlying integument; draw the integument upward and expose the end of the needle through a short incision made down upon it; push the end of the needle through the opening, and thread it with a strong sterilized silk thread or silver wire; withdraw the needle, leaving the ligature in place; unthread and pass the needle through the same primary opening upward in front of the fragments and out of the upper incision (Fig. 1750); rethread the needle with the upper end of the cord and withdraw the needle so that the
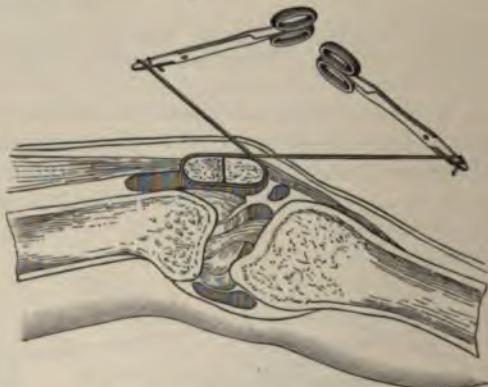
FIG. 1751.—The operation of ligature of patella, Barker's method. Twisting wire ligature; bringing fragments together.

ends of the silk will both present at the lower incision; approximate the fragments, and displace intervening blood clots and other material by rubbing them together briskly; tie the suture tightly, cut the ends short and close the wound (Fig. 1751). A posterior splint and a figure-of-eight bandage are then applied. Passive motion is begun on the tenth day in the majority of cases. The patient may be up and around with a plaster-of-Paris dressing in three weeks.

The Results.—Good use of the joint is expected in two months. That this plan is comparatively safer than the ones opening the joint freely there can be no reasonable doubt. The practical outcome can not be known without a more extended experience.

Another subcutaneous method (Ceci) consists in surrounding the frac-

tured bone subcutaneously with a buried silk ligature in quite the same manner as Lejars employs in multiple fracture of the patella, and in fracture at its tendinous insertions, passed transversely through the ligamentum patellæ at its insertion into the fragment, and so carried around the bone, passing through the quadriceps attachment (Fig. 1752), as to draw the fragments tightly together in a hooplike manner when the suture is tightened, and tied at the point of primary puncture (Fig. 1753). The ordinary curved pedicle needle can be employed to draw the suture into place. Owing to the circular shape of the bone, the ligature must be laid in segments, the needle being reinserted at the point of exit in each instance until the primary puncture is reached, when the suture is tied as just described.

The Remarks.—The suture should be carried sufficiently deep at the sides to penetrate the firm tissues connected with the patella at those situa-
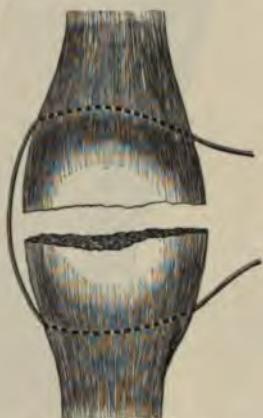
FIG. 1752.—The operation of subcutaneous (wire) ligature for fracture of patella, Ceci's method.
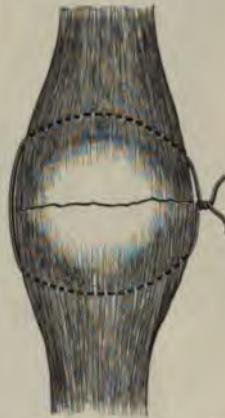
FIG. 1753.—The ligature united in Ceci's method. Silver wire may be used instead of silk.

tions, in order to properly control the fragments. In comminuted fracture the plan serves to unite the fragments closely. The remaining advantages claimed for the method are of questionable worth. Other methods of arrangement of the suture have been suggested and occasionally practiced.

In old fracture of the patella, especially with wide separation of the fragments causing a badly crippled limb, union of the broken parts in some instances requires division of the quadriceps tendon, and even the rectus itself, along with the vasti muscles, and perhaps then suitable apposition can not be secured without separation by mallet and chisel of the tuberosity of the tibia from the normal si   nd its transplantation and fixation at a higher point on the bone.

The Anatomical Points.—1   width of the tendon of the
quadriceps, and the   most fibers of the vasti
in health, show   ion is commenced.
These lo   ntaining the

patella in proper relation with the lower end of the femur, may have become so changed in their structure and function as to prevent apposition of the bony fragments unless they are freely divided, which division, however, quite severs the musculo-tendinous flap, thus depriving the attached fragments of the patella from nourishment, and exposing to serious danger of sloughing. The writer once encountered this obstacle in a marked degree. The relation which the site of operation bears to the joint cavity merits careful attention (Fig. 433).

The varieties of the liberating incisions employed are usually three in number: (a) the triangular; (b) the gable-shaped; (c) the crenated (Fig. 1754). In either instance the incisions should be made through the tissues,
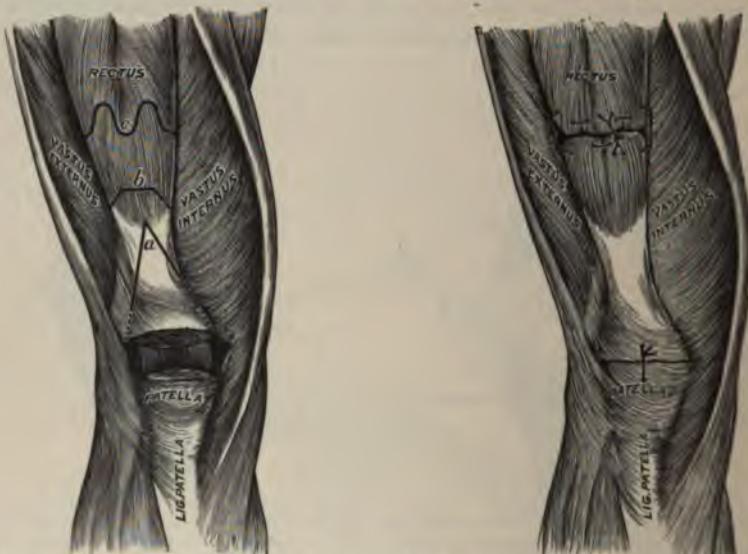
Fig. 1754.—The operation of elongation of the quadriceps in old fracture of patella. a. Triangular incision with dotted lines indicating extension of incisions. b. Gable-shaped incision (Keen). c. Crenate (Cheyne).

Fig. 1755.—The ends in crenate incision adjusted to each other, united together, and patella repaired (Cheyne). In instances a and b (Fig. 1526), elongation followed by adjustment and suturing of contiguous borders are required.

and after their elongation and the adjustment of the bony fragments, the contiguous borders of the former are sutured together (Fig. 1755). The longitudinal incision affords the greatest and the remaining incisions the least degree of elongation. The greater the need for lengthening, the higher and more extended the oblique incisions should be made.

The Precautions.—Strict asepsis should be practiced. The incisions should conform strictly to the needs of proper joining of the bony fragments. In displacement upward and implantation of the tuberosity of the tibia, great caution is necessary not to seriously impair its power of union with the new point of attachment. Since septic infection may invade and ruin the exposed joint and the union of the soft and hard parts,

destroying their respective portions, thereby causing defeat of operative purpose and possibly loss of life, it is evident that the operation should be counseled only with wise discretion and performed with consummate care.

The Results.—*Keen, Erdmann*, and others have practiced these methods successfully. Several successful cases from other sources are reported.

Rupture of the Tendon of the Quadriceps Extensor Femoris.—The quadriceps tendon is sometimes ruptured from direct and indirect violence. Rupture may be mistaken for fracture of the patella, and, in fact, be entirely overlooked.

The Operations for Rupture.—In cases where *ruptured muscular extremities* can be brought together they may be suitably united by means of a supporting thread in the form
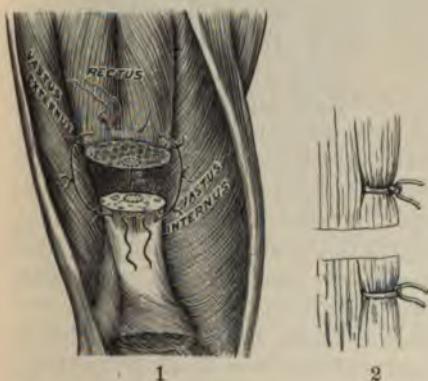
FIG. 1756.—1. Method of suturing divided muscle. Four sutures placed ready for tying to the bundles of muscle, and three are already tied to each other. 2. The arrangement of individual sutures, each grasping a bundle of fibers (page 302, vol. i.).

FIG. 1757.—Rupture of tendon of quadriceps extensor femoris. Uniting ruptured ends. *a.* Anterior continuous adjustment sutures. *b.* Posterior continuous adjustment sutures. *c.* Basting stitches. *d.* Tendon of quadriceps.

of a transverse loop passed through both of the ruptured extremities, supplemented by a few stitches for finer adjustment of the torn edges (Fig. 1756). In cases where the *ruptured ends are tendinous* (Fig. 1757), pass a long, heavy silk thread, by basting stitches, transversely through the two ends, about half an i   edges; unite by a continuous suture of fine silk the ____   he ruptured ends. Now tie the transverse sutur   r margins with a continuous suture, ove·   d skin. In cases where the *tendon i*   pass a loop of

97*

silk or silver wire so as to include the upper segment of the torn tendon above and the patella below (Fig. 1758). Draw the ends of the loop taut, thus bringing together the separated surfaces, completing the apposition by a continuous suture uniting the apposed edges. *If the gap be too large for coaptation of the ruptured ends, Championnière* recommends suturing at a distance by passing a loop of silver wire, basted in and out, around the lower part of the upper segment of the tendon, not far from its torn margin. This acts as a splint to support in this situation the two or three longitudinal stitches of approximation which are made to pass through the tendon just above it. Below, the longitudinal stitches pass either around a similar transverse splint stitch placed near the torn margin of the lower segment,

or, if the latter is not of sufficient length, through the patella itself. The longitudinal stitches are likewise of silver. Around this metallic structure, in young subjects, it is possible that the area of loss of substance can be filled in by the development of regenerative fibrous bundles.

The Remarks.—If the bursa lying beneath the tendon (Fig. 433, *a*) has been ruptured it should be repaired, and due cognizance of the possible outcome on the knee joint from this cause be considered and provided for.

The Results.—Walker's analysis of 250 cases shows that 72.5 per cent recovered within six months under mechanical treatment, also that 86 per cent recovered completely within the same time under operative treatment. Walker states that operation should always be practiced when a greater separation than an inch and a half is present, and when mechanical measures have failed.

FIG. 1758.—Rupture of tendon of quadriceps extensor femoris. Uniting ruptured end of tendon with patella. *a, d.* Wire sutures. *b.* Basting stitches. *c.* End of tendon. *e.* Patella.

Suture of the Olecranon Process.—The olecranon process is sutured for non-union after fracture and for recent fracture. Under strict asepsis expose the seat of fracture through a median longitudinal incision; uncover the fractured surfaces by removing intervening tissue or blood clots; begin at corresponding points of sound bone about a quarter of an inch from the border of either fragment and drill a small hole obliquely through the fractured surface; pass through the openings fine silver wire, silk, or kangaroo tendon, and firmly appose the fragments; close the wound, apply the dressings and immobilize the joint with the arm completely extended (Fig. 1759). The passage of kangaroo tendon or silk through the tendon of the triceps near to its point of insertion, and through a hole made transversely through the ulna just below the fracture, is an admirable method of suture. In either instance the torn borders of the fibrous extension overlying the olecranon should be sutured together with catgut (Fig. 1760). In case the tendon is ruptured it is repaired in the same manner as is the tendon of the quadriceps extensor muscle.

The Remarks.—Suture of recent fracture of the olecranon is rarely

advisable except when the separation is so great as to render doubtful the serviceability of the limb. In cases of crippling from non-union, the method finds its greatest use. Passive motion should be commenced early and employed with caution. The suture should not be passed in contact with the articular surface.

The Union of Fractured Long Bones.—The fractured ends of a long bone sometimes persistently override each other in spite of the efforts to
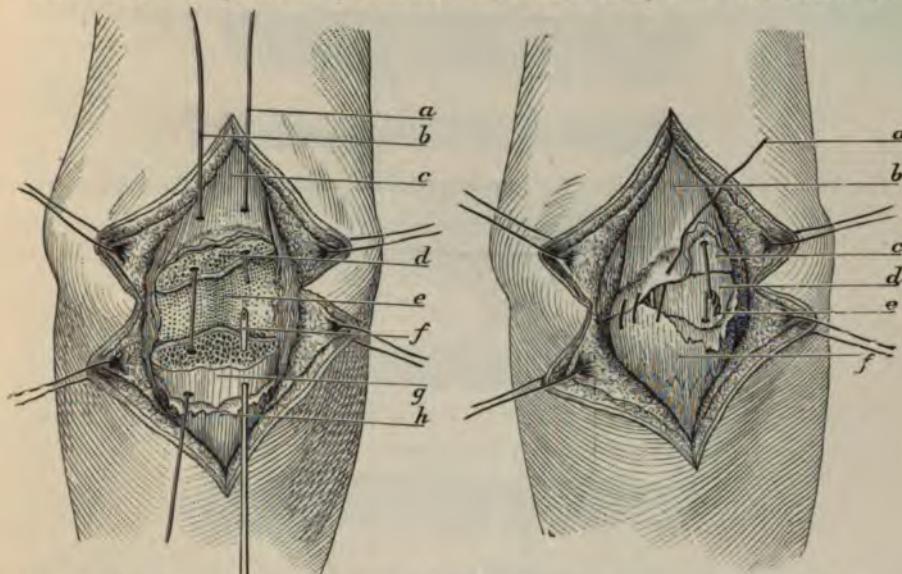
FIG. 1759.—The operation of suture of olecranon process. *a, b.* Wire sutures. *c.* Tendon of triceps muscle. *d.* Broken surface of upper fragment of olecranon. *e.* Trochlear surface of humerus. *f.* Bone drill. *g.* Lower portion of olecranon process. *h.* Periosteum.

FIG. 1760.—The operation of suture of olecranon. *a.* Continuous suture uniting torn periosteum. *b.* Tendon of triceps. *c.* Upper fragment of olecranon. *d.* Lower portion of olecranon. *e.* Wire suture in place, ends twisted and turned down. *f.* Periosteum.

reduce and retain them in place, causing serious deformity, protracted and incomplete recovery, and perhaps exposing to injury important contiguous structures. Both simple and compound fractures are often liable to these

FIG. 1761.—Suture of transverse fracture with one suture. Another may be introduced at opposite side.

FIG. 1762.—Suture of transverse fracture with a single suture.

FIG. 1763.—Suture of oblique fracture with single suture. An insecure method.

objections. It is proper, however, to state that attem~~~~ ~~lief by the following methods of treatment are now less frequen~~ merly, and that their utilization is not wise unless

tions of more than usual interest to the welfare of the patient. *Three methods of uniting* the fragments are employed: 1, by suture; 2, by ligature; 3, by pegging.

In suture of bone, either silver or platinum wire or heavy silk may be employed.

In transverse fracture, perforate the bone perpendicularly to the surface
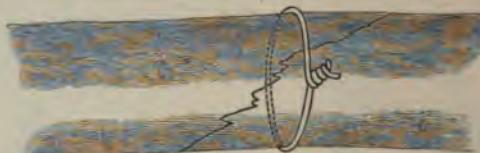
FIG. 1764.—Ligature of oblique fracture by peripheral method. Not the most secure.

FIG. 1765.—Oblique ligature of oblique fracture, peripheral method. The most secure.
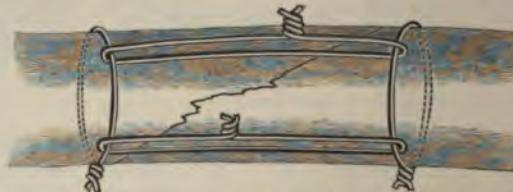
FIG. 1766.—Double circular ligature of oblique fracture, with two longitudinal loops. Ligatures should surround seat of fracture.

and employ either two sutures, one at either side (Fig. 1761), or a single suture passing transversely through both fragments (Fig. 1762).

In oblique fracture, drill the fragments so that the suture will be at right angles to the line of fracture, otherwise the movement is not controlled (Fig. 1763). The ends of the wire suture are twisted, the excess cut off, and the remainder hammered against the bone.

FIG. 1767.—Combined ligature and suture of oblique fracture.

Ligature of bone is employed in cases of exceedingly oblique and comminuted fractures. In this method simple peripheral ligature and ligature combined with suture are employed.

The former procedure, while not the most secure, is often serviceable. The ligature can be carried around the bone at the point of the greatest tendency to separation, either at right angles with the long axis of the bone (Fig. 1764) or with the direction of the fracture (Fig. 1765). In either instance the bone

should be notched at the seat of application, to hold the ligature firmly in place, and supplementary suture may be made when needed. Two circular ligatures passed around the seat of fracture and united together with two longitudinal loops may be employed (Fig. 1766).

Combined ligature and suture (Fig. 1767) is performed by drilling perpendicularly to the line of the fracture, through which opening a loop of wire is passed. The threads are crossed within the bone, then caused to encircle the bone snugly one at either side, and the protruding ends are
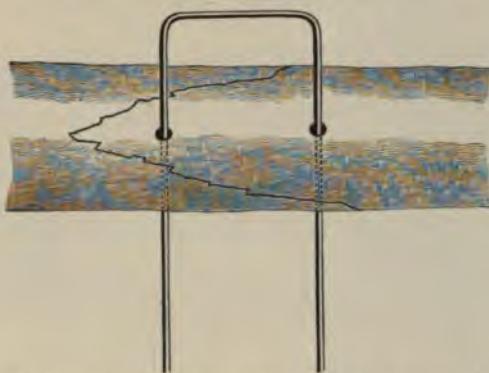
FIG. 1768.—Frame ligature of oblique fracture, first step.
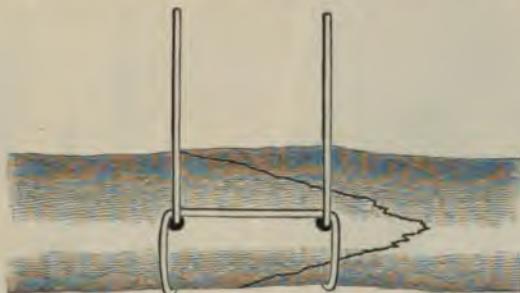
FIG. 1769.—Frame ligature of oblique fracture, second step.
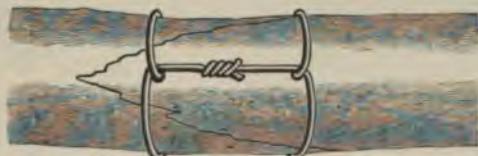
FIG. 1770.—Frame ligature of oblique fracture, operation completed.

passed through the loop and fastened. An accessory ligature may be employed if the fracture be very oblique.

The frame ligature provides degree of immobility. Drill two holes through ngle to the long axis of the bone (Fig. 1768). wire through them; draw

the loop over the ends at the opposite side of the bone (Fig. 1769); draw
the ends tight, carry them around the shaft of the bone to the openings,
pass them beneath the respective wires, bring them together, and twist
firmly in place (Fig. 1770).

The pegging of fractures by *peripheral* and *intramedullary* introduction
of pegs of ivory or of decalcified and of fresh bone is not infrequently prac-
ticed. In oblique (Fig. 1771) and multiple (Fig. 1772) fractures, union
by drilling and pegging together of the fragments is often a commendable
procedure, better, in fact, than wiring. Fracture may be united by nailing
(Fig. 1512).

Intramedullary pegging is practiced in the continuity of long bones
(Fig. 1773) as follows: Make the site of the fracture gape by lateral flexion;
drive the peg into the lower fragment with light strokes as far as suitable;
grasp the lower fragment, bend it strongly laterally and downward until
the free extremity of the peg can be introduced into the medullary cavity
of the upper fragment, when the two are driven together. The periosteum
is then sutured in place (Fig. 1774), the limb dressed aseptically and fixed
by a plaster-of-Paris dressing.

In instances of loss of bone structure in which the periosteum cor-
responding to the intermediary space is intact, a peg may be introduced into
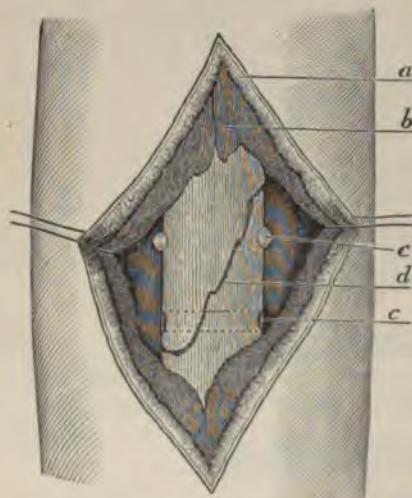
FIG. 1771.—Pegging single oblique fracture,
   peripheral method. *a, b.* Soft parts. *c.*
   Pegs. *d.* Line of fracture.
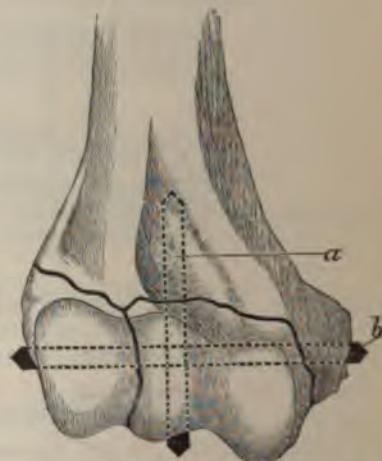
FIG. 1772.—Pegging multiple fracture,
   peripheral method. *a, b.* Vertical
   and transverse pegs.

the respective medullary openings of the upper and lower fragments, thus
retaining them in their proper relation. The periosteum is then sewed
around the peg and the limb dressed as before (Fig. 1775). In the young
successful outcomes from this plan of practice are reported.

The Remarks.—Strict asepsis must be practiced and immobility secured
if successful results are expected. Fragments of bone not properly vitalized,

because of crushing or of loss of periosteum, offer but little chance of proper repair. The form of suture or ligature should be employed that best meets the indication without causing undue disturbance of the soft parts and of the fragments during its application. Pegging of long bones by the peripheral plan usually is better than union by suture or ligature. Ivory pegs are the easiest of.introduction and of application. Decalcified bone is soft and suited only for certain cases. Fresh bone is excellent, but difficult to prepare. The pegs should snugly fit the openings, and be cut off so as to be
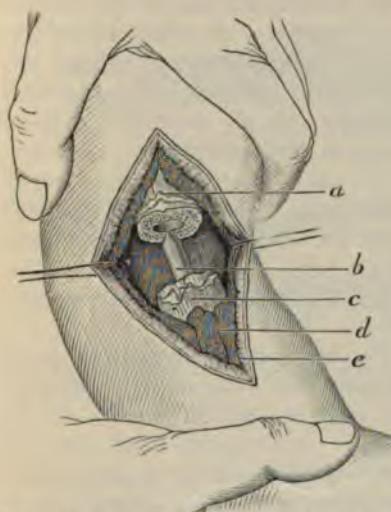
FIG. 1773.—Pegging fracture of long bone, intramedullary method. *a*. Periosteum of upper fragment. *b*. Pin with one end introduced. *c*. Periosteum of lower fragment. *d, e*. Soft parts.
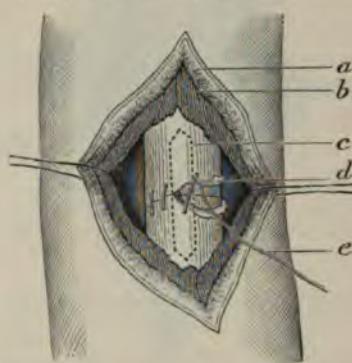
FIG. 1774.—Closing periosteum over pegged fracture of long bone by intramedullary method. *a, b*. Soft parts. *c*. Outline of pin. *d, e*. Sewing of borders of periosteum.

readily covered with the periosteum. Medullary pegs should fit closely, and be introduced far enough to obviate lateral deviation—an inch to an inch and a half will suffice. However, the upper end of the peg can not be caused to penetrate the corresponding fragment as far as the lower.

Parkhill has secured commendable results from fixation of the fragments by a special apparatus devised by himself. The ends of the fragments are suitably adjusted by means of resection, the use of the rongeur and Volkmann's spoon. "Each fragment is drilled transversely to the longitudinal axis of the bone in two places. A small steel pin is thrust into the first hole while the second is being drilled, in order that they may be made parallel. The distance that these pins should be from each other and from the ends of the bones should be determined by the bone under operation and by the size of the clamp to be used. The screws are introduced into these holes by means of a clock key, and the wings are adjusted. While the bones are held in accurate apposition, the halves of the instrument are clamped together" (Fig. 1776).. The soft parts are then accurately adjusted around the screws (Fig. 1777), and the dressing   d, leaving the clamp outside. The apparatus is r   weeks, depending on the size of the bone. Th   nce in the use of this

appliance, leaves its employment to the judgment of the profession. *Parkhill's* experience justifies a belief in its utility in suitable cases.

Nailing the Head of the Femur (Schede).—There are two conditions for the relief of which this procedure has been employed: first, for recent fractures, when some coexisting condition, such as the age of the patient or the existence of some deformity, renders it inexpedient to subject the sufferer to prolonged mechanical treatment with the attendant risks of non-union and exhaustion; and, second, in cases of ununited fracture of the neck of the femur. Treatment by Buck's extension, until so far as possible the normal length is restored, should precede all operative attempts.

The operative treatment in these cases was first suggested by Langenbeck, and successfully carried out by König.

König operated in a case of recent fracture, making *a small incision over the outer side of the trochanter major*, drilled a hole through it with a metal drill in the direction of the head of the bone, applied extension to the limb to the extent necessary to overcome the deformity, and then drove a long steel nail through the canal in the trochanter into the head of the bone and left it there. The limb was then immobilized and extended for six weeks. There is no record of the ultimate shortening, but good union and free motion of the joint were obtained.
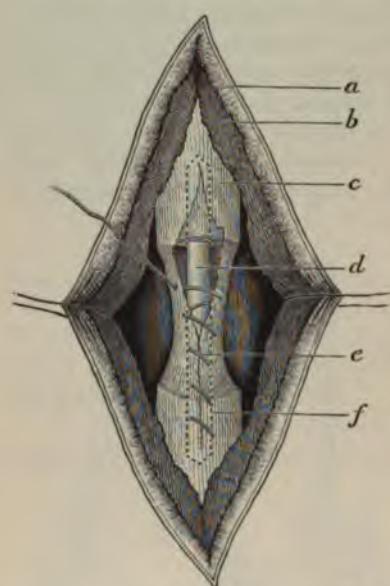
Fig. 1775.—Intramedullary pegging of fracture of long bone, with loss of substance, periosteum being sewed around peg. *a, b.* Soft parts. *c.* Periosteum. *d.* Peg. *e.* Periosteum sewed over peg. *f.* Outline of peg.
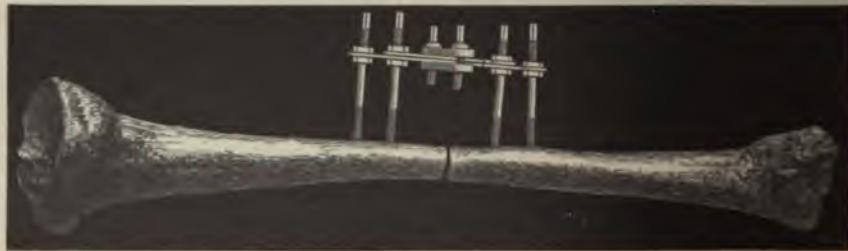
Fig. 1776.—Fixation of fragments in fracture of long bone, Parkhill's method.

Cheyne, in a case of recent fracture, exposed the fragments through a *longitudinal incision* made *over the anterior aspect of the joint,* exposed the

fracture, made extension and internal rotation on the limb, and with the fingers in the wound manipulated the fragments into place; then a small longitudinal incision was made over the outer side of the trochanter major, and two canals drilled through the fragments at a distance of half an inch apart. Ivory pegs were then driven through the holes made by the drill,
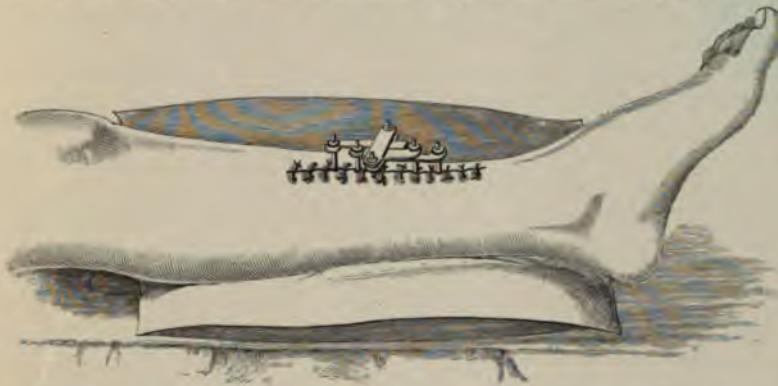
FIG. 1777.—Fixation of fragments in fracture of long bone, Parkhill's method. Soft parts adjusted.

and the limb immobilized. Good union and motion were obtained, but there is no record of measurements of the limb.

In operating upon cases of ununited fracture the refreshing of the ends of the fragments is a necessary step in the technique.

Meyer, in a case of ununited fracture with three inches shortening, made *the Langenbeck incision for excision of the hip joint* (Fig. 449), exposed the seat of fracture, scraped the ends of the fragments until

FIG. 1778.—Fixation of fragments in fracture of neck of femur, Parkhill's method.

they bled, reduced the deformity by extension of the limb, and fastened them together by driving two nails through the trochanter major. A useful joint was obtained with an inch and a half shortening of the

98

limb. *Parkhill* commends this method for fracture of the neck of the femur (Fig. 1778).

Gillette reports three cases of ununited fracture of the neck of the femur operated upon in the following manner:

A horseshoe incision with its convexity downward was made, beginning an inch below and an inch posterior to the anterior superior spine of the ilium, carrying it down two inches below the trochanter major and bringing it up the buttocks to about the center of the gluteus maximus muscle. The skin and the two layers of fascia were dissected up *en masse*. A chain saw was then passed between the posterior border of the tensor vaginæ femoris and the gluteus medius, hugging the neck of the femur and the base of the trochanter major; it was brought out between the posterior surface of the gluteus medius and the anterior surface of the gluteus maximus; the trochanter major and its muscular attachments were sawed off, turned back, thus exposing the capsule of the joint. Then, by making a longitudinal incision into the capsule the fracture could be easily seen. The surfaces of the fractured ends were denuded and a bone peg driven through the neck of the femur, thus holding the fractured ends together. The capsule was stitched with catgut, the trochanter major restored and nailed in place with a small bone peg, the skin closed, and the limb immobilized.

There was union and good motion obtained in all the cases, with shortening of from an inch to an inch and a half.

Curtis, in a case of ununited fracture of the neck of the femur of three months' standing, exposed the fracture *through an anterior incision* (page 428), passed a drill into the callus and between the fragments to cause irritation, applied extension to the limb and reduced the deformity, after which a drill was passed through the trochanter major from the outer side, transfixing the fragments; the handle of the drill was then removed and the drill itself left *in situ*. The anterior wound was closed and the limb immobilized. The extension was maintained for six weeks, at the end of which time the drill could be easily removed. Good union and a useful limb were obtained with three quarters of an inch shortening.

Freeman [*] treats of this operation in a recent illustrated article in an interesting manner. He reports 15 cases with 1 (before asepsis) death and 14 recoveries, with good functional results in all. The cases of Curtis and of Cheyne with similar results should be added, making 16 with good results and 1 fatal.

The Remarks.—There is yet a reasonable doubt regarding the advisability of this operation except in special cases. The difficulty of securing and maintaining proper adjustment of the fragments because of the lack of command of the inner portion, its porous character and low vitality, present obstacles to success that can not be gainsaid. The degree of shortening that follows the successful results suggests an initial failure of reduction of the deformity or the maintenance in proper place, and bespeaks in any event a considerable amount of absorption at the seat of the fracture. A more extended experience is needed and a careful comparison of the favorable

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[*] Annals of Surgery, vol. xl, page 568.

results by different methods of treatment is required before a final judgment can be recorded.

Movable Bodies in Joints.—*Movable bodies in joints, joint derangement, defective semilunar cartilages* (menisci), *and abnormal synovial folds* ("tabs") are conditions quite often confused with each other, and, in fact, are not positively distinguishable without operative demonstration. If a movable body appear beneath the surface, the patient should remain as quiet as possible pending the arrival of the surgeon, who should then transfix it at once with a sharp needle, if feasible, to prevent its escape into the recesses of the joint while preparation is being made for its removal. Strict asepsis should be enjoined in every respect. Either an oval incision, including the site of the movable body, or one made directly upon it, may be employed. The tissues are divided carefully down upon the object, and it is then removed if disconnected, and clipped off with scissors if connected, as it sometimes is, to the semilunar cartilage or synovial fold. The synovial incision is carefully and independently closed with a continuous suture of fine chromicized catgut. The incision in the fibrous capsule should be treated in a similar manner. The remaining portion of the wound is closed with interrupted silkworm-gut sutures. If it should appear that the trouble is dependent on derangement of a semilunar cartilage (meniscus), and the obstinacy of the affliction forbids the expectation of other than operative relief, a transverse or a broad-based oval incision with the base upward should be made over the seat of the cartilage in question. The joint is carefully opened, the cartilage exposed to view, and its movements carefully noted as the leg is flexed and extended. If it be too freely movable because of a stretched or ruptured coronary ligament, thereby permitting it to be caught between the advancing articular surfaces, the ligament should be shortened and sewed with chromicized catgut to the periosteum at the border of the tibia. If the ligament has been torn away from its fastening to the tibia, it should be restored in place and fastened the same as before, by sewing. If it be roughened or deformed so as not to operate without a hitch, its movements should be restricted as much as possible by sewing in the manner already stated. If it be doubled upon itself, or so much deformed as to unfit it for use, it should be removed at once.

The Precautions.—Strict asepsis should be applied throughout the operation. Antiseptic solutions ought not to be permitted in contact with the exposed surfaces, especially those of the joint cavity itself. The exploration of the joint cavity through a free incision for the purposes of diagnosis and possible removal of the offending cause should not be attempted unless it shall appear that the burden of the infliction and of its consequent effects on the joint are of equal significance to those arising from explorative practice.

The Remarks.—The cartilages are normally movable because of the need of their action to facilitate the functions of the joint. The diagonal division into two parts of a too freely movable cartilage, and the stitching of each independently to the periosteum at the border of the tibia, is commended by some operators. However, the majority regard removal ** ˙˙ more satisfactory practice. The divided borders of the respec

of the wound are united the same as in the preceding instance. Drainage need not be made unless faulty technique is suspected. Operative practice is not advised until after other and simpler means of relief have failed, except when a movable body presents itself beneath the surface, and then, should it escape into the joint, it is better to await a reappearance than to open the joint and seek for it at once. Transverse incisions weaken the joint more than the vertical. Atrophy of the quadriceps muscle (Hoffa) may permit the capsule to be pinched between the patella and femur or the femur and tibia. Ruptured crucial and other ligaments may be repaired by sewing them in place, but useful joints follow such injuries without operative interference. *Tenney* * in a recent extended article adds much, indeed all phases of this question.

The Results.—The following statistics will emphasize the outcome of operative practice more pointedly than words alone can do. Also the comparative importance of aseptic measures and perfected technique are strikingly shown:

	Number of cases.	Cured per cent.	Failures per cent.	Mortality per cent.
Beamdorf............................	216	66.2	18.99	14.81
Lorry (1860)........................	167	68.86	19.76	11.38
Browne (1884).......................	88	82.95	5.68	12.36
Tuttle..............................	107	97.19	2.81	......

Tenney reports 297 operations on " non-purulent knee joints" done since 1895, with 6 instances of ankylosis, no amputation, and no death.

The Frontal Sinus.—It is sometimes necessary to open the frontal sinus to liberate inflammatory products and remove foreign bodies, etc.

The Anatomical Points.—The frontal sinuses are spaces developed at either side by separation of the tables of the skull at that situation. The development begins at about two years of age and continues usually during life, so that the sinuses are therefore largest in old age. They vary in capacity, sometimes being an inch in depth, and may extend halfway up the forehead. They are commonly separated in the median line from each other by a bony septum, are lined with mucous membrane, and communicate freely with the nasal cavity through the infundibulum.

The Operation of Opening a Frontal Sinus.—Shave and cleanse the supraorbital area thoroughly, administer an anæsthetic, and place the patient on the back with the shoulders raised and the head extended; make an incision from the center of the supraorbital ridge inward along the upper border of the eyebrow to the median line above the root of the nose; raise and push aside the periosteum, and with a chisel and mallet make a small opening through the anterior wall of the cavity (Fig. 308); cleanse the sinus thoroughly and remove the diseased products. The wound of the soft parts should be closed at once, except at the inner angle, which is left open for drainage purposes. If the infundibulum be patent the external wound

* Annals of Surgery, vol. xl, July, 1904.

may be entirely closed at once. It is better, however, to introduce a strand
or two of silkworm gut through the canal into the nasal cavity, leaving the
upper ends exposed at the angle of the wound for two or three days before
removal, than to rely at once on the uncertainties of the maintenance of
drainage along narrow channels lined with mucous membrane with fickle
characteristics. When extensive disease is present requiring much time for
cure, it is wise to drain through into the nose or pharynx with a tube of
considerable size (Fig. 1779).

The Comments.—All that is practicable should be done to prevent scar-
ring and infiltration of the loose tissues about the orbit. The eyes should be
carefully protected from the discharges and from the antiseptic fluids em-
ployed in the treatment. The in-
fundibulum runs downward and
backward for a short distance,
then turns sharply forward and
downward, and enters the nasal
cavity—facts that should be re-
membered in probing the canal.

The Maxillary Sinus.—The
maxillary sinus or the antrum of
Highmore is of great importance
in connection with facial disfigure-
ment and functional impediment,
due to encroachment on the orbital
and nasal fossæ of the morbid
products arising from disease of
the antrum.

The Anatomical Points.—The
antrum of the adult is a triangu-
lar-shaped cavity of considerable

FIG. 1779.—Draining frontal sinus into
pharynx.

size, bounded above by the orbital floor, below by the alveolar process,
within by the wall of the nasal fossa, and without by the malar process of
the maxilla. It is lined with mucous membrane and communicates with
the middle meatus of the nasal fossa by a small opening. The relation of
the floor of the antrum to the roots of the teeth varies widely; it may
extend so as to correspond to the roots of nearly all the teeth of the true
maxilla, or may be so contracted as to bear a definite relation with only
one or two of the posterior molars. Occasionally the roots of one or more
of the posterior molar teeth project into the floor of the antrum, incased,
however, normally, by a thin plate of bone covered with mucous membrane.

The Operation of Opening the Maxillary Sinus.—The antrum is opened
through the socket of a molar tooth, or through the facial surface of the
maxilla at a point corresponding to the root of the second or third molar
tooth into the inferior meatus. In the former instance the second or third
molar tooth is extracted and the socket is perforated above by means of a
bone drill carried carefully upward through the floor of the cavity. If the
tooth in question be diseased, the removal only may suffice to secure an
opening. In either instance the op   ' uld be enlarged sufficiently by

the introduction of a larger drill to permit of a free discharge and cleansing of the cavity. When the available teeth of the afflicted side have been long removed and atrophy of their former sites has taken place, the opening is then made at a point on the anterior surface of the bone corresponding to the former location of the second or third molar tooth. The cheek is drawn aside and the lip turned upward, followed by an incision of the mucous membrane and periosteum over the selected site. The soft parts are drawn aside, the bone exposed and perforated in an upward direction by means of a small trephine, or a large trocar, or bone drill, or strong scissors. The opening of the antrum into the inferior meatus through the bony partition below the inferior turbinated bone is sometimes practiced. This opening can be easily and directly made with a drill or bur. However, the annoyance from the discharges and from cleansing in these cases is often more objectionable than are similar affections of other methods.

The Precautions.—It is wise to first remove the diseased tooth that complicates the antrum involvement, as it only may be the exciting cause of the trouble. The perforating agent should be introduced with care and proper restraint, or it may perforate the floor of the orbit. A careful examination of the diseased products should be made at once, to determine the nature of the disease. If a scoop be used to remove the diseased tissue, care should be taken not to needlessly expose healthy bone, as necrosis will quite surely follow the exposure. Careful cleansing and complete control of the entrance of food through the opening should be maintained, for obvious reasons.

The Comments.—Whether or not a sound tooth should be sacrificed to afford a point of entrance, or an opening of the facial surface be made at once, is a matter of some dispute. In our opinion the former plan will give greater satisfaction in the majority of instances, because the opening is likely to exist for a long time, and often is permanent. In the latter class of cases much better control can be had of the exit and entrance of matters than when the opening is at the facial surface.

The After-treatment.—Thorough cleanliness should be maintained by frequent cleansing of the cavity through the opening until the disease is cured. For this purpose the aperture should not be allowed to close until final relief is secured, when, if closure will follow without discomfort, it may be encouraged. A tube with an adjustable plug may be worn in either case, but one connected with an appliance fitted to the gap left in the biting line from the removal of the tooth is less annoying and better controlled than one inserted in an opening at the anterior surface. A competent mechanical dentist can do much to increase the comfort and efficiency attending the employment of continuous drainage.

Operations on the Cervical Sympathetic Nerve.—*Jonnesco* describes three degrees of operative practice on the nerve that can be employed for relief from disorders related to the sympathetic nerve influence: 1. Simple incision; 2, partial resection; 3, total resection.

Other surgeons preceded Jonnesco in the practice of partial resection, limited, for example, to the superior cervical ganglion of both sides (Alexander), the middle ganglion of the left side (Bojdanick). Jonnesco to excise the entire sympathetic in the neck.

The Operation.—With the shoulders and head raised, and the head turned to the opposite side and exposed to a good light, make an incision from the posterior border of the mastoid process downward, along the posterior margin of the sterno-cleido-mastoid to a point a little below the clavicle; expose and divide the external jugular vein between two ligatures; isolate the posterior border of the sterno-mastoid and split it in the continuity of the structure near to the margin; separate the deeper tissues along
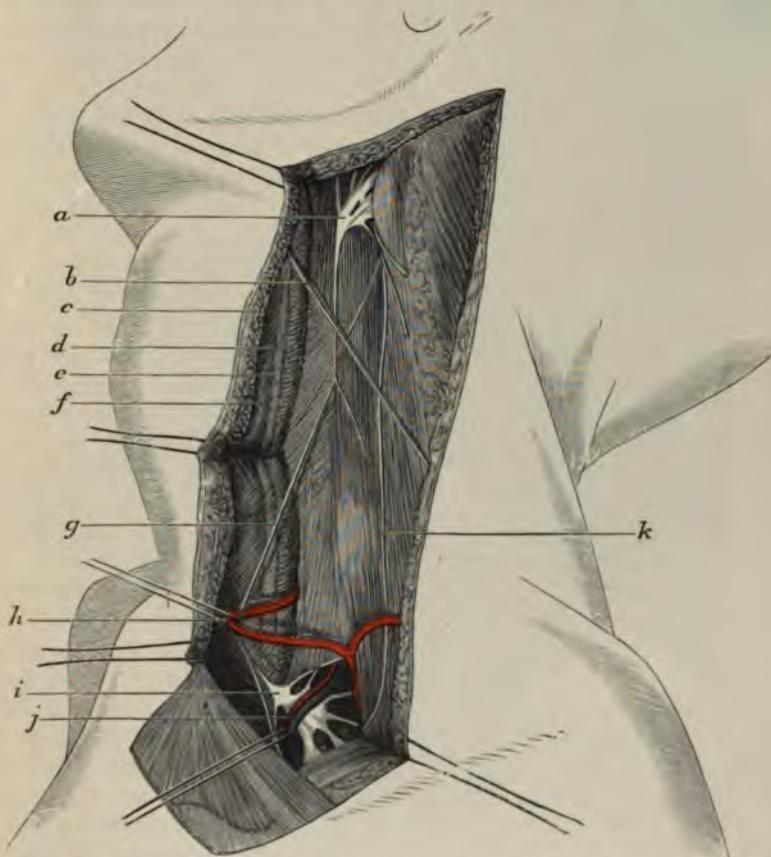
Fig. 1780.—The cervical sympathetic nerve and ganglia. *a.* Superior cervical ganglion. *b.* Branch of cervical plexus. *c.* Sterno-mastoid muscle. *d.* Common carotid artery in sheath. *e.* Pneumogastric nerve in sheath. *f.* Internal jugular vein in sheath. *g.* Branch of sympathetic. *h.* Inferior thyroid artery. *i.* Inferior cervical ganglion. *j.* Vertebral artery and vein. *k.* Phrenic nerve.

the line of incision, carefully avoiding injury to the associated vascular and nervous structures; draw apart the borders of the wound and seek for the nerve near the middle of the wound as it lies in its established relations ...id, the longus colli, and scalenus anticus muscles ... upward the trunk of the nerve to the supe- ...glion, divide its communicating filaments

and those of the exposed trunk of the nerve, and remove the ganglion and the trunk; seize with forceps the distal end of the lower part of the trunk and put it upon the stretch; separate downward carefully the trunk from the contiguous tissues to the inferior thyroid artery; dissociate cautiously the artery from the intimate intervals of nerves, in the midst of which may be found and isolated the middle cervical ganglion (Fig. 1781); trace still farther downward the main trunk deeply into the neck and seek for the inferior ganglion where it lies behind the clavicle, closely associated with the head and neck of the first rib and the pleura beneath (Fig. 1782); apply a retractor at either side of the wound so as to include externally the scalenus anticus muscle, thyroid, suprascapular, and vertebral arteries and veins; at the inner side the sterno-cleido-mastoid muscle and deep vessels; grasp with forceps and free the ganglion by blunt dissection from the vertebral vessels without and the costo-vertebral structures within; divide with small, blunt-pointed scissors the ramifications of the ganglion, cautiously shunning the important contiguous structures, and remove it along with the portion of trunk attached above; arrest hæmorrhage and unite the borders of the wound by deep and superficial sutures; dress the wound aseptically, confine the head and neck closely, and quiet the patient with an anodyne.
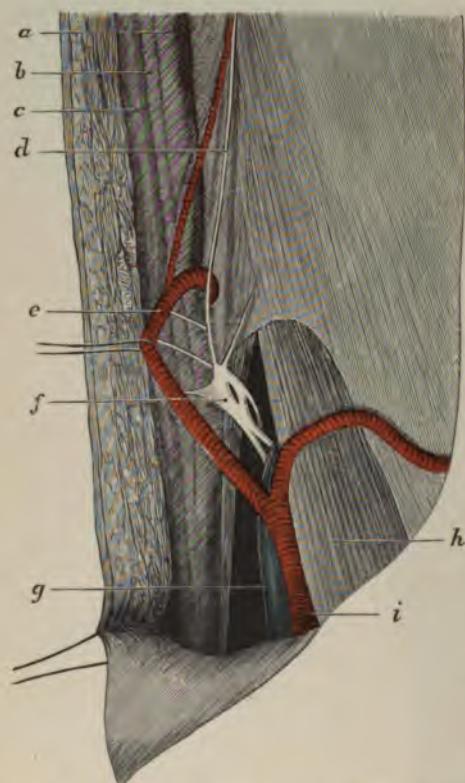
FIG. 1781.—The middle cervical ganglion of cervical sympathetic nerve. *a*. Common carotid artery in sheath. *b*. Pneumogastric nerve in sheath. *c*. Internal jugular vein in sheath. *d*. Sympathetic nerve. *e*. Inferior thyroid artery. *f*. Middle cervical ganglion. *g*. Vertebral vein. *h*. Scalenus anticus muscle. *i*. Thyroid axis.

The Precautions.—Thorough asepsis and a clear appreciation of the anatomy embraced in the procedure are essential requirements. Involvement of the pleura and important vessels and nerves is to be avoided. Be not too confident of a favorable therapeutic outcome.

The Remarks.—*Jonnesco* regards approach to the nerve by splitting the posterior border of the sterno-mastoid muscle as less troublesome than exposure of and passing under the border. The superior ganglion is the largest of the three, is located opposite the second and third cervical verte-

bræ, sometimes as low as the fourth or fifth. It lies behind the sheath of the carotid and upon the rectus capitus anticus major muscle. The middle ganglion is the smallest of the three and is sometimes wanting. It is located opposite the sixth cervical vertebræ, is closely associated with the inferior thyroid artery, hence denominated thyroid ganglion. The inferior cervical ganglion is situated between the base of the transverse process of the last cervical vertebra and the neck of the first rib at the inner aspect of the superior intercostal artery. It is next in size to the superior ganglion. The inferior ganglion usually lies inside the vertebral artery and invests this vessel with its branches. Sometimes this ganglion is friable and removed piecemeal.

The Results.—*Jonnesco* reports the following outcome secured by himself and others in this operation:

1. *Simple incision* has been done by Jaboulay three times with good
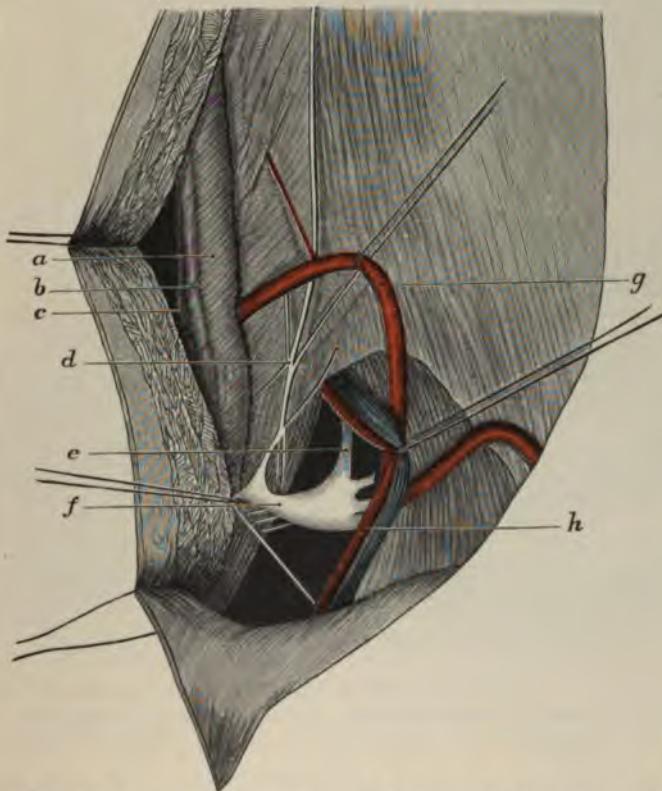
Fig. 1782.—The inferior cervical ganglion and the sympathetic nerve. *a.* The carotid artery in sheath. *b.* Pneumogastric nerve in sheath. *c.* Internal jugular vein in sheath. *d.* Middle cervical ganglion. *e.* Vertebral nerve. *f.* Inferior cervical ganglion. *h.* Vertebral artery and vein. *g.* Inferior thyroid artery.

operative ˈ   regeneration at the seat of division
makes t   ˈˌy.

2. *Partial Resection.*—All the nerves down to the thyroid artery and the superior ganglion have been removed 27 times, 33.3 were cured, 40.7 were improved, 7.4 not improved, and 18.6 died. The relative rates remain quite *the same.* Jonnesco reports 7 instances practiced for *glaucoma,* in all of which the operation was limited to the superior ganglion. Post-operative effects slight and transitory. Immediate reduction of intraocular tension and progressive amelioration of vision followed. Jonnesco also reports 26 *epileptics* who were subjected to the operation. In " some cases " the cure was maintained for a year, others were notably improved both as to frequency of fits and mental state. All were improved and no case was made worse.

Rehn reports 32 cases of Graves's disease treated by operation on the cervical sympathetic with 28.1 per cent cured, 50 per cent improved, 12.5 per cent not relieved, and 9.3 per cent died. He also shows that above twice as many cases follow thyroid extirpation as attend operation on the sympathetic with, however, a higher rate of mortality, viz., 13.6 per cent, and 9.3 per cent respectively.

Complete Resection (bilateral).—Seventeen cases are reported, 58.9 per cent cured, 29.4 per cent improved, 11.7 per cent not improved.

The removal of foreign bodies from the hand and elsewhere about the human body through a longitudinal incision made directly down upon the

Fig. 1783.—Locating in right hand a foreign body by the X ray, palmar view. Scar indicated by longitudinally placed pin. Area divided into equal spaces by three transversely placed pins. Foreign body seen at ulnar side of longitudinal pin.

supposed site, and by means of a >-shaped incision so placed that the apex of the > should conform with the point of entrance of the foreign body and the limbs to its direction in the tissues, and located so as to include in the triangular flap the object sought for, are methods of practice of good repute, long since established. The employment of these methods has, however, been followed by disappointed effort in the search and by severe after-effects. The advent of the X ray reduced the hitherto uncertain outcome of

sightless operative effort to the basis of substantial scientific success in all instances. But a single instance is needed to illustrate the plan of action employed by the writer. In this particular instance long, tedious, and unsuccessful search under general anæsthesia had failed to locate a fragment of broken needle. In this, as in other instances, a fine needle was carried superficially through the toughened cuticle in the long axis of the scar caused by the previous effort. This step caused no pain and the needle was held securely in place. Three additional needles were then passed through the cuticle at right angles to the preceding needle at definite equal distances from each other, thus dividing the corresponding area into four equal spaces.

Fig. 1784.—Locating in right hand a foreign body with X ray, side view. Showing depth of foreign body and its relation to the pins on palmar surface.

An X-ray photograph was then made of the palmar and lateral aspects of the hand (Figs. 1783 and 1784), showing the depth in the tissues of the foreign body and its comparative relation to the topography outlined by the needles.

The proper seat of incision for removal of the foreign body is thus made obvious, and one has but to adhere to the line of incision without deviation with an abiding faith in success.

The Remarks.—The extremity should be placed in an even manner on a horizontal surface when photographed. After the picture is taken the needles should be removed and their respective sites indicated on the surface for subsequent observation. Frequent instances demonstrating the utility of this plan of action have happened since the foregoing announcement. One especially of removal of a needle from the deep muscles of the forearm with prompt and unerring precision after prolonged and repeated efforts by the older means of practice.

THE COMMON DEFORMITIES OF THE EXTERNAL EAR.

The lobe and the auricle of ear are common and most objectionable sites of di of these parts cause strong appeals for relief bec tions. Oversensitive persons not infrequent ar deviations of so little

apparent significance as to pass unnoticed by others, and which like the
nose may be better suited to the physiognomy of the individual than any
other form of adjustment. Great discretion should be
exercised in encouraging operative desire in such
cases, since a failure to secure betterment or the caus-
ing of disappointment are often equally disastrous to
the comfort of the patient and the surgeon. Only
three operations for remedying protuberant auricles
are here considered.

Keen's* Method.—Remove an oval-shaped piece of
skin of suitable size from the posterior surface of the
auricle, midway between its free and attached borders,
going down to the cartilage (Fig. 1785); remove from
the cartilage of the auricle in the line of the preceding
incision a V-shaped piece of cartilage (Fig. 1785, *b*),
the apex of the V not disturbing the skin; adjust the
borders of the divided tissues with each other and close
the wound with silkworm-gut sutures so passed as to
include the edges of the cartilage posteriorly.

FIG. 1785.—Operation
for protuberant ear,
Keen's method. *a*.
excision of skin and
cartilage. *b*. Out-
line of excision of
cartilage.

The Comments.—The complete division of the
cartilage or a too abrupt bending when uncut, causes,
after proper adjustment, a marked linear deformity in
front corresponding to the line of deflection. In Keen's case the cartilage
of one ear was divided, in the other it was not, yet both made an equally
satisfactory recovery.

Monks's† Method.—Monks makes a distinc-
tion between cases in which it is and is not
necessary to remove a section of cartilage.
The former class relates to ears with stiff car-
tilage, as in adults, the latter to the pliable
cartilage, especially those of children.

The Technique.—Remove from the back of
the auricle an elliptical-shaped area of skin,
with the inner limit near the sulcus (Fig.
1786) and the broadest part at the seat of the
greatest deformity of the auricle; remove a
V-shaped piece of cartilage (Fig. 1785, *b*) in
the line of the denuded area when the cartilage
is stiff, and when limber bend the cartilage suit-
ably, uniting the divided edges of the cartilage
independently with catgut in the former and
the skin borders of the denuded area in both in-
stances with silkworm gut.

FIG. 1786.—Operation for pro-
tuberant ear, Monks's meth-
od. Integument removed
and cartilage exposed.

The Remarks.—The amount of skin removed should equal in breadth
rather more than half of the back of the ear, in order at first to over-

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* Proceedings Philadelphia Co. Med. Soc., vol. xxiv, p. 84, 1891.
† Boston Med. and Surg. Jour., vol. cxxiv, p. 84, 1891.

correct the deformity, thus obviating later the tendency of the cartilage to regain its old position. The long axis of the ear may be regulated by diagonal arrangement of the sutures between the divided borders. The ears should be bound quite firmly against the head from ten to twenty days with a bandage, and a night-cap should be worn afterward for several months.

The Results.—In one case when a section of the cartilage was removed the ear was drawn back satisfactorily, but a vertical fold of skin was found on the front of the ear where the edges of the cartilage had been apposed. In three children, one, five, and nine years old, after operation by excision of the skin only, the results continued satisfactory for nine months, two months, and two weeks, respectively—during which times they were under observation.

Haug's * Method.—Make a curved incision (*a* Fig. 1787) in the auriculo-cephalic furrow for nearly its entire length; make a second curved
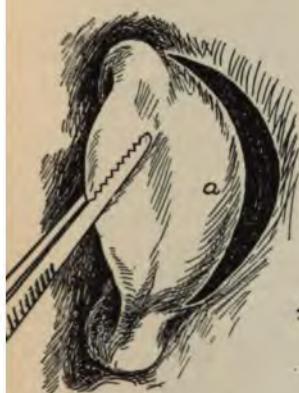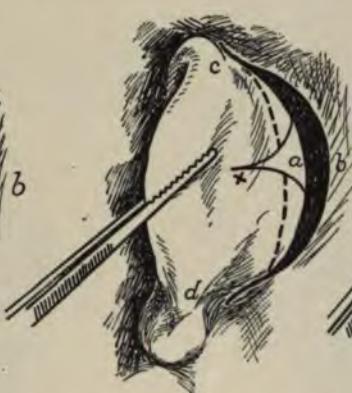
FIG. 1787.   FIG. 1788.   FIG. 1789.

FIG. 1787.—Operation for protuberant ear, Haug's method. Making the curved incisions (*a* and *b*).

FIG. 1788.—Operation for protuberant ear, Haug's method. Showing denuded area, incisions *a* and *b*. Dotted line showing extent of dissection. + V-shaped cartilage incision.

FIG. 1789.—Operation for treatment of protuberant ear, Haug's method. Haug's flap (*a* Fig. 1788) sewed in place.

incision (*b* Fig. 1787) over the mastoid process, the two incisions outlining a half-moon-shaped area from which the skin is dissected off; carry from the upper and lower angles of this area an incision (*c* and *d* Fig. 1788), going through the skin on to the back of the auricle; reflect the outer skin margin to about half the length of each of the incisions (dotted line, Fig. 1788), thus forming a crescentic flap smaller in size than the denuded area over the mastoid; draw the flap (*a*) strongly backward and sew it to the edge (*b*) (Fig. 1789).

The Remarks.—If the auricle is very resistant, then incise the cartilage in the lines *a* and *c* for about half its thickness and similarly in a line

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* Deutsche Medicinische Woch., Bd. xx, p. 776, 1894.

on the back of the auricle between these two, after which fracture it at these situations by firm pressure. Also make a V-shaped incision (Fig. 1788) into the cartilage at the middle of the reflected flap (*a*), with subsequent fracture. Be careful to preserve the skin anteriorly in fracturing the cartilage. This plan obviates the tedious procedure of cartilage excision. The length of the upper and of the lower cartilage incision is about 1 centimeter, and of the middle about 1 to 1½ centimeters.

Ablation of the Antitragus (Guermonprez).—The ablation of this part of the ear is sometimes required for removal of a morbid growth or some other form of disfigurement.

The Operation.—Make an incision around three sides of the growth, omitting the supero-external aspect; remove the morbid part along with a portion of the healthy ear posteriorly, as indicated in the illustration (Fig. 1790), with a sharp, narrow-bladed bistoury; remove two V-shaped portions, as indicated above the preceding incision (Fig. 1791), after first dissecting up the skin sufficiently for the purpose; suture separately the anterior and posterior borders of the wound, thus closing the gap; dress the wound carefully, holding the parts securely in place with bandages.

Restoration of the Lobe of the Ear.—Ordinary wounds of the lobe and the disfigurements due to earrings can be readily cured by refresh-

FIG. 1790.—Ablation of the antitragus, Guermonprez's method. Outline of incision.

FIG. 1791.—Ablation of the antitragus, Guermonprez's method. Disease removed, V-shaped portions indicated.

ing the borders of the defects and sewing them together. However, it sometimes happens that the lobe can not be repaired except by tissue taken for the purpose from other sources. Only one method of repair for this disfigurement will be given, viz.:

Nélaton's Method.—In this case the lobe of the ear was so badly damaged (Fig. 1792) that the material for repair was taken as follows:

The Technique.—Raise an oval-shaped flap from the integuments below the auditory canal, including some of that of the mastoid region, so formed that there will be no traction made on it when properly placed; fashion the flap so that the portion of integument to which the lobule was formerly

attached will be at the middle (Fig. 1792), the free border of which should be freshened the entire length; unite the borders just freshened to

FIG. 1792.—Operation for restoration of the lobe, Nélaton's method. Flap outlined and borders freshened.

FIG. 1793.—Operation for restoration of lobe of ear, Nélaton's method. Borders sutured and lobe restored.

the freshened borders of the auricle with sutures (Fig. 1793); fold the flap so as to bring the raw surfaces in contact with each other, and unite these raw edges, thus forming a new lobe; close the denuded area by skin grafting or by uniting its borders, as may seem proper at the time; adjust the repaired ear as near like the other as possible, and confine it in place with proper dressings until repair takes place.

INDEX.

1908	NAME	DATE DUE
C. E. Brown	ret	April 29 1915
J. L. Barry	ret	MAR 6 1916
Benj H Crane	ret	April 6 1917
HSC Jordan	ret	Sept 5, 1917
C. L. Venner	ret	April 27 1918
H. E. Ford		Jul May 16, 19—
H. Townsend		